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BOEING

Queen City Farms
Vertical Barrier Wall System

January 1998

HAYWARD BAKER
A Keller Company

KELLER

Kennedy/Jenks Consultants
Engineers & Scientists

USEPA SF
1532682

VERTICAL BARRIER WALL DESIGN
PROJECT CLOSURE REPORT

QUEEN CITY FARMS SUPERFUND SITE
MAPLE VALLEY, WASHINGTON

Prepared for

The Boeing Company

Submitted by

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K/J 956052.01

January 1998

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

LIST OF ACRONYMS

API	American Petroleum Institute
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
BDA	Buried Drum Area
cm/sec	centimeters per second
CD	Consent Decree
EPA	U.S. Environmental Protection Agency
H:V	horizontal to vertical
GCL	geosynthetic clay liner
IRM	Initial Remedial Measure
LNAPL	Light Non-Aqueous Phase Liquid
O&M	Operation and Maintenance
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
pcf	pounds per cubic foot
ppm	parts per million
psf	pounds per square foot
PVC	polyvinyl chloride
QCF	Queen City Farms
RA	Remedial Action
Report	Construction Closeout Report
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SB	soil bentonite
SOW	Statement of Work
Sta.	station
TP	turning point
TRD	Task Remedial Design
TSP	total suspended solids
VBWS	vertical barrier wall system

1.0 INTRODUCTION

This Project Closure Report (Report) describes the implementation of the vertical barrier wall system (VBWS) component of the remedial action (RA) for the Queen City Farms (QCF) Superfund Site (site) near Maple Valley, Washington. The VBWS component of the RA consisted of three elements: (1) a vertical soil-bentonite (SB) barrier wall, (2) a multi-layered cover system over the area enclosed by the SB barrier wall, and (3) a surface water collection system. This Report addresses the requirements presented in the Record of Decision (ROD, U.S. EPA 1992) and the Remedial Action Report (Section XVI) of the Statement of Work (SOW) attached to the 8 November 1993 Consent Decree (CD, U.S. EPA 1993).

This Report contains the following sections:

- Section 1.0 describes the QCF site, presents a brief site history and synopsis of the VBWS component of the RA and summarizes VBWS construction activities.

- Section 2.0 presents modifications to the Final Task Remedial Design (TRD, Kennedy/Jenks Consultants 1996) required during construction and the reasons for these modifications.

- Section 3.0 presents the criteria established to judge performance of the VBWS component of the RA and describes how the RA met performance criteria.

- Section 4.0 discusses long-term operations and maintenance (O&M) requirements for the VBWS.

- Section 5.0 certifies that applicable construction-based performance standards have been met.

- Section 6.0 includes references for documents cited or used in preparation of this Report.

This Report also contains the following appendices:

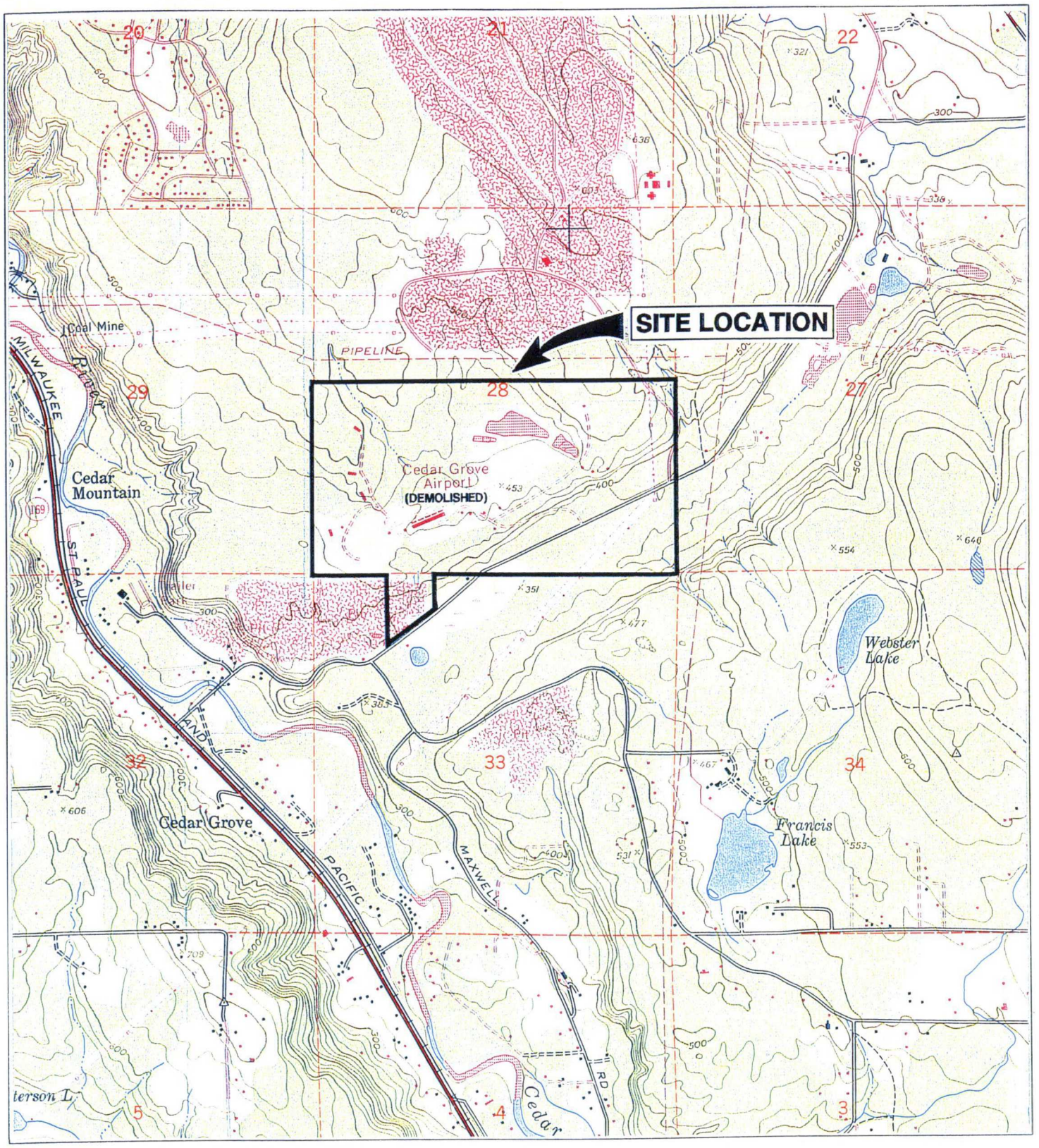
- Appendix A - As-Built Record Drawings
- Appendix B - Design and specification modifications.

1.1 SITE DESCRIPTION

The QCF site occupies 320 acres in a rural section of south King County near Maple Valley, Washington (see Figure 1). The site is located on a rolling upland area on the north side of the Cedar Grove Channel, a broad northeast-southwest trending valley. Queen City Lake, a seasonal water body, is located in the north-central portion of the site.

The northern section of the site is bounded by the Cedar Hills Landfill. The western boundary of the site is bordered by wooded land and a gravel sorting operation owned by Stoneway Concrete. The southern boundary is bordered by the Stoneway Concrete facility, private residences, and an undeveloped marshy area. The eastern side of the site is generally bordered by 228th Avenue Southeast.

From the mid-1970s until 1992, the site was used for sand and gravel mining. A 26-acre section in the northwestern portion of the site is currently used for yard-waste composting, and heavy equipment is stored in the western section.



REFERENCE: Landau, Figure 1-4, 1992

N

0 1000 2000

SCALE IN FEET
CONTOUR INTERVAL 25 FEET

REFERENCE: USGS 7.5' TOPOGRAPHIC QUADRANGLE
MAPLE VALLEY, WASHINGTON 1949
PHOTOREVISED 1968 AND 1973

Kennedy/Jenks Consultants

QUEEN CITY FARMS
MAPLE VALLEY, WA

VICINITY MAP

956052.01/P5SK009

FIGURE 1

1.2 SITE HISTORY

In the CD, the U.S. Environmental Protection Agency (EPA) identified two locations on site where hazardous substances had been released (see Figure 2). These two locations are (1) Ponds 1, 2, and 3, and (2) the Buried Drum Area (BDA).

Ponds 1, 2, and 3 were unlined ponds located in the northeastern section of the site. These ponds were used from approximately 1955 until the late 1960s for disposal of industrial waste liquids including paint, petroleum products, oils, and organic solvents. Ponds 1, 2, and 3 were the focus of the Initial Remedial Measure (IRM) performed in 1986. The IRM included removal and offsite disposal of contaminated liquids and sludge, construction of a cover over contaminated soil, installation of a ground and surface water diversion system, and groundwater monitoring.

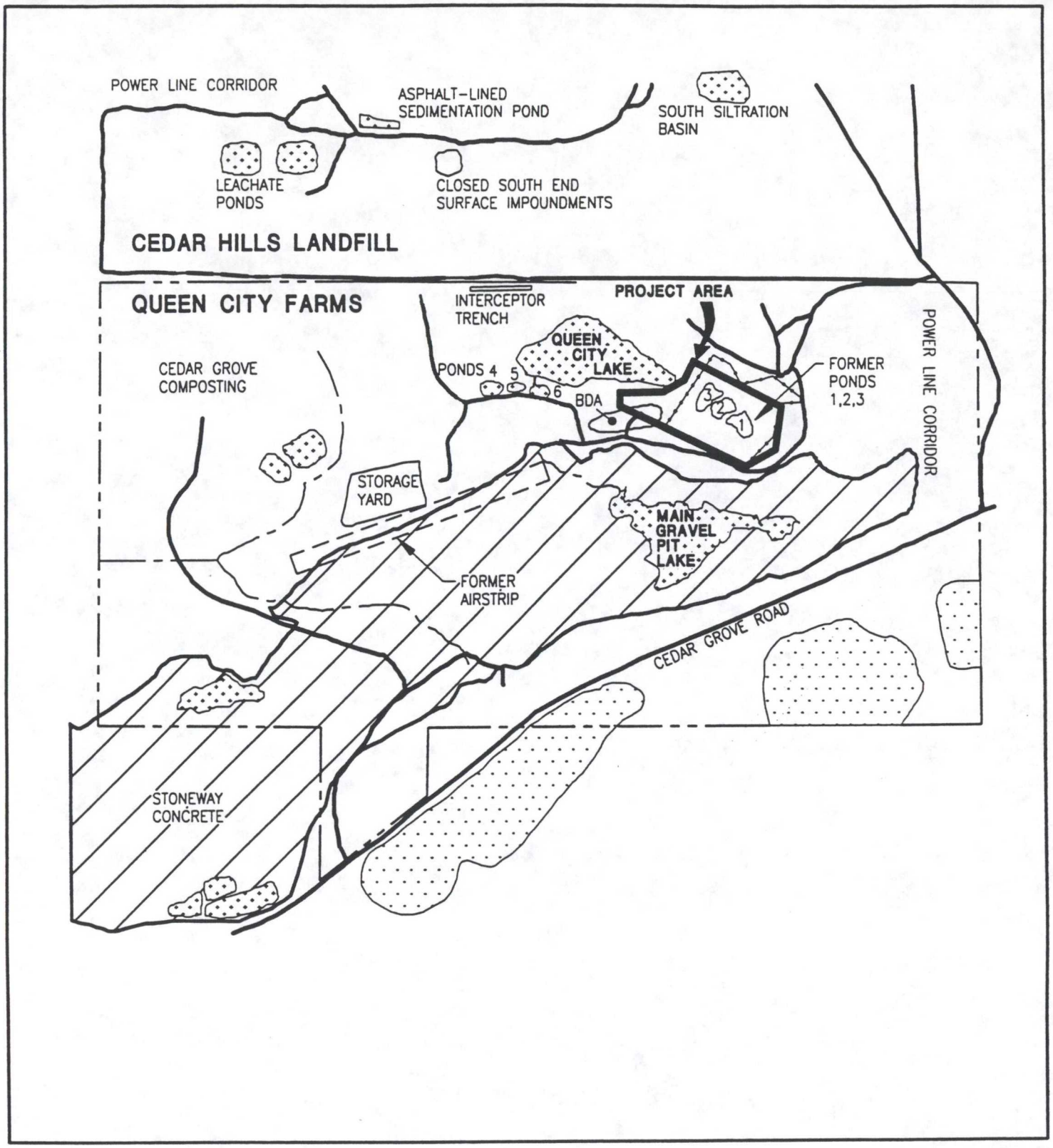
The BDA, located south of Queen City Lake and west of the IRM area, contained buried crushed drums, contaminated soil, liquid wastes, and other materials. Some of these materials were removed and disposed offsite in 1988. The remainder of the BDA was remediated in the summer of 1995.

EPA issued a ROD based on the findings of the site Remedial Investigation/Feasibility Study (RI/FS). The ROD required the following RA:

- Construction of a vertical barrier system around residual contaminated soil in the IRM area.

- Removal and offsite incineration of light non-aqueous phase liquid (LNAPL) from within and adjacent to the IRM.

- Extraction followed by treatment and offsite discharge of groundwater from the IRM area.



(REFERENCE: LANDAU, FIGURE 1-3, 1992)

LEGEND

- WATER BODIES
- SWAMP
- APPROXIMATE EXTENT OF GRAVEL MINING (MAY 1992)
- ----BOUNDARY
- ----STREAMS

N

0 400 800

APPROXIMATE SCALE IN FEET

Kennedy/Jenks Consultants

QUEEN CITY FARMS
MAPLE VALLEY, WA

SITE PLAN

956052.01/P5SK014

FIGURE 2

- Contingent extraction followed by treatment and discharge of groundwater outside the IRM.

- Passive venting of IRM soil.

- Excavation of soil and debris from the BDA, followed by treatment and offsite and onsite disposal. Soil and debris disposed of onsite would be placed below an extension of the existing IRM cover.

- Construction of a surface water diversion system to reduce infiltration of water into the IRM/BDA cover.

- Deed restrictions and institutional controls.

- Long-term groundwater, drinking water, and surface water monitoring.

The RA for the BDA was completed during the summer of 1995. Approximately 11,000 cubic yards of polychlorinated biphenyl (PCB)-contaminated soil and debris were excavated and sorted for disposal. Approximately 8,700 cubic yards of this soil contained PCB concentrations less than 100 parts per million (ppm) and were stockpiled onsite. This material was relocated under the cover extension inside the barrier wall and as part of the barrier wall RA.

1.3 PROJECT DESCRIPTION

This VBWS RA involved the following components:

- Installation of a vertical barrier wall around the IRM area. The vertical barrier was constructed of SB with a minimum thickness of 3 or 4 feet, as shown on the Record Drawings. The alignment of the barrier wall and other construction details are shown in the As-Built Record Drawings (Appendix A).

- Construction of a multi-layered cover system. This system consisted of the following components (in descending order from the ground surface to the subgrade):

Component	Thickness (feet)
Grass and wildflower ground cover	—
Silty sand and gravel	1 foot
Cobbles	2 feet
Sand	2 feet
Polyvinyl chloride geomembrane	30 mils
Silt/Geosynthetic Clay Liner	2/as specified

- Construction of a surface water collection system to reduce infiltration into the IRM/BDA area. Surface water runoff from the cover system discharges to Queen City Lake and Main Gravel Pit Lake.

1.4 SUMMARY OF CONSTRUCTION ACTIVITIES

This section presents a brief chronology of construction activities at the site based on Daily Inspection Reports prepared by Kennedy/Jenks Consultants and Daily Activity and QC Reports prepared by Hayward Baker, Inc. Copies of these reports were filed with Boeing throughout the course of construction.

Dates	Activity
16 - 19 April 1996	• Construction of bentonite slurry mixing, slurry hydration, and water storage ponds • Arrival and assembly of Koehring 1466 Excavator • Arrival of D6 Dozer, 966F Loader and 140 G Grader • Installation of silt fence along construction area perimeter along north and west site boundaries • Demolition of corrugated metal pipe drain on east side of project area • Grading and excavation of working platforms along south and east portions of wall alignment begins • Drilling of water supply well on nearby private property per agreements with property owner

Dates	Activity
22 - 26 April 1996	• Arrival of 950 F Loader and 3 off-road dump trucks • Steam cleaning and painting of 1466 Excavator • Lining of water pond with HDPE • Water supply pipeline construction using welded 20-foot long, 4-inch diameter HDPE pipe sections • Excavation of work platform from station 18+00 to 16+50 as per design • Filling of working platform along southwest section of wall alignment with soils from excavation between stations 16+50 to 18+00 • Buried drums and stained soil encountered in excavation area; stained soil excavated (approximately 2,000 cubic yards) and placed near Buried Drum Area stockpile • Construction of working platform from station 15+50 to 16+50 as per design using soils excavated from stations 16+50 to 18+00
29 April - 3 May 1996	• Arrival and preparation of dry bentonite storage trailer, slurry mixing pumps, Hong West field trailer (lab), and crawler crane with clam shell (Manitowoc 4000W) • Excavation of work platform from station 15+50 to 20+00 as per design • Construction (fill) of working platform near stations 6+50 and 13+50 and southwest section of project area as per design • Completion of water storage, bentonite slurry mixing, and bentonite slurry hydration ponds • Filling of water storage pond with water from water supply well • Repair of minor damage to silt fence due to construction activities • Hydroseeding of north slope between stations 10+00 and 13+79 for erosion control
6 - 10 May 1996	• Assembly of 1466 Excavator and clam shell • Increased depth of water supply well to increase capacity • Delivery of bentonite for slurry mixture • Batching of bentonite slurry mix • Survey of barrier wall centerline • Hauling and stockpiling of excavation soils from working platform construction for mixing of barrier wall backfill material • Excavation of working platform from stations 20+00 to 21+35 as per design • Construction of working platform near stations 10+00 and 15+00 as per design • Excavation of barrier wall trench from station 18+97 to approximately 18+00
13 - 17 May 1996	• Excavation of barrier wall trench from station 18+00 to 16+10 as per design • Construction of SB mixing area in southern section of project area • Mixing soil and bentonite for backfill material • Bentonite slurry discharge from barrier wall trench[a]

Dates	Activity
20 - 24 May 1996	• Completion of work required to halt bentonite slurry discharge[a] • Installation of and repairs to silt fence and straw bales at access road near station 13+79 after control of bentonite slurry discharge[a] • Completion of barrier wall trench excavation from station 18+97 to 16+00 as per design • Excavation of barrier wall trench from station 18+97 to 21+00 as per design • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation • Enlargement of SB mixing pit to increase production capacity • Placement of SB backfill mix from station 16+00 toward 18+97
28 - 31 May 1996	• Excavation of barrier wall trench from station 21+00 to 21+35 as per design • Excavation of working platform between stations 12+00 and 16+00 and at interior corner in vicinity of station 21+35 as per design • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation • Placement of SB backfill mix at station 16+00 toward station 18+97 • Routine maintenance of erosion control facilities to maintain proper function
3 - 7 June 1996	• Excavation of barrier wall trench completed from station 18+97 to station 21+35 as per design • Excavation of barrier wall trench between stations 16+50 and 15+50 as per design • Grading of working platform between stations 9+99 and 8+60 • Routine maintenance of erosion control facilities to maintain proper function • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation • Placement of SB backfill mix at station 16+00 toward station 21+35
10 - 14 June 1996	• Breaking and removal of boulders in barrier wall trench at stations 15+20 and 14+40 using H-beam chisel to achieve design depth • Excavation of barrier wall trench to station 13+90 as per design • Excavation of work platform to station 8+00 (approximately) • Routine maintenance of erosion control facilities to maintain proper function

Dates	Activity
17 - 21 June 1996	• Barrier wall trench excavation from station 13+79 to 12+80 as per design • Survey of centerline from station 13+79 to station 8+60 upon completion of working platform construction and prior to trench excavation to re-establish horizontal control of trench alignment • Placement of SB backfill mix at station 17+00 toward station 13+79 • Grading of working platform from station 18+97 to station 21+35 as per design • Stockpiling of silt from Stoneway borrow pit to be used in cover system
24 - 28 June 1996	• Excavation of barrier wall trench from station 12+80 to 11+00 • Survey centerline from station 12+43 and station 9+99 upon completion of working platform construction and prior to trench excavation to re-establish horizontal control for trench alignment • Placement of SB backfill mix at station 14+70 toward station 12+43 • Placement and compaction of embankment fill in lifts between stations 18+97 and 21+35 • Separating cobbles from Stoneway borrow soils for use in cover system • Miscellaneous grading
1 - 3 July 1996	• Placement of SB backfill mix near station 20+00 toward station 21+35 as per design • Grading of working platform between stations 18+97 and 21+00 as per design • Grading, filling, and compacting of embankment soils in lifts between stations 21+00 and 18+00 as per design • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation
8 - 12 July 1996	• Excavation of barrier wall trench from station 10+60 to 9+99 • Excavation of work platform between station 10+40 and 8+60 to an elevation 4 feet lower than originally designed to accommodate equipment and minimize excavation with clam shell • Excavation of work platform near station 20+00 • Placement and compaction of embankment soils between stations 17+00 and 21+00 as per design • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation
15 - 19 July 1996	• Excavation of barrier wall trench from station 9+99 to 8+60 as per design • Excavation of work platform near station 9+00 • Placement and compaction of Stoneway silt in lifts from Station 17+30 (approximately) to station 18+97 (approximately) as part of cover system • Excavation and grading of working platform from station 15+00 to 17+30

Dates	Activity
15 - 19 July 1996 (continued)	• Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation • Placement of SB backfill mix at station 13+50 toward station 12+43
22 - 26 July 1996	• Excavation of barrier wall trench from station 8+60 to 8+20 • Excavation of work platform in vicinity of station 21+35 to 1+50 • Grading embankment soils near station 12+00 • Placement and compaction of lifts of embankment soils in eastern section of construction area • Placement of SB backfill mix at station 12+90 toward station 9+99 • Placement and compaction of Stoneway silt in lifts near station 17+50 (approximately) • Excavation and segregation of stained soil located near station 8+60
29 July - 2 August 1996	• Excavation of barrier wall trench from station 21+35 to 22+39 as per design • Excavation of work platform in vicinity of station 1+50 to 2+00 as per design • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation • Placement of SB backfill mix between stations 9+99 and 12+43 as per design
5 - 9 August 1996	• Excavation of barrier wall trench from stations 0+00 and 0+80 • Removal of out-of-specification Stoneway silt from vicinity of station 18+00 • Excavation of work platform in vicinities of station 2+50 and 7+99 • Placement and compaction of Stoneway silt in lifts between stations 16+00 to 21+00 (approximately) of the cover system area • Cleaning of barrier wall trench in various locations with clam shell to remove materials sloughed from side walls of trench during excavation • Placement of SB backfill mix in northwestern (approximately 12+00 to 7+99) and western sections (approximately 21+35 to 0+10) of trench
12 - 16 August 1996	• Excavation of barrier wall trench from station 0+80 to 2+60 • Placement and compaction of silt in lifts along northern & eastern sections of the cover system area • Excavation and grading of work platform between stations 8+60 and 7+99 and along southern section of barrier wall alignment • Excavation between stations 11+00 and 12+00 to make room for BDA material • Rough grading of subgrade from station 8+75 to 13+25 • Stockpiling of Stoneway silt for use in cover system • Cleaning of barrier wall trench along southern portion of trench with clam shell to remove soils sloughed from side walls of trench during excavation • Placement of SB backfill mix in several locations along length of trench to top off backfil

Dates	Activity
19 - 23 August 1996	• Excavation of barrier wall trench from station 2+60 to 4+10 • Placement, grading, and compaction of Stoneway silt along northern & eastern sections of cover system area • Preparation of work platform along southern section of trench alignment • Placement of SB backfill mix between stations 0+00 and 7+99 • Stockpiling of Stoneway silt for use in cover system
26 - 30 August 1996	• Excavation of barrier wall trench from station 4+10 to 6+30 as per design • Final preparation of silt layer on northern & eastern sections of cover system area • Placement and compaction of Stoneway silt in lifts from station 12+00 to 14+50 of cover system area • Placement of embankment soil in area near stations 7+99 and 8+60 • Placement by Layfield Plastics of PVC liner from station 14+50 to 21+35 • Placement of SB backfill mix between stations 0+00 and 7+99
3 - 6 September 1996	• Completion of entire length of barrier wall trench excavation • Cleaning of barrier wall trench in various locations with clam shell to remove soils sloughed from side walls of trench during excavation • Preparation of subgrade from station 0+00 and west for placement of cover system materials • Placement and compaction of Stoneway silt in lifts from station 12+00 to 14+50 • Placement of SB backfill mix in southern section (near station 5+00) of trench • Dismantling and backfilling of slurry hydration pond • Solvent welding of PVC liner between stations 14+50 and 21+35 • Rough grading of northeastern section (8+75 to 12+00, approximately) • Bentonite slurry discharge from barrier wall trench[(b)]
9 - 13 September 1996	• Demolition and filling of slurry mixing pond • Placement and compaction of Stoneway silt on top of barrier wall between stations 21+35 and 3+00 • Completion of SB backfill from station 0+00 to station 7+99 • Grading of slope north of barrier wall between stations 14+50 and 18+45 • Excavation of soil from west central section of site to create storage vault for BDA materials and placement of vault excavation soils in east central section of site • Decontamination of slurry transfer pump • Placement of geotextile on northern and eastern sections of wall alignment as part of drainage system as per design • Stockpiling and spreading of import sand along geotextile as part of design drainage system

Dates	Activity
16 - 20 September 1996	• Stockpiling and spreading of sand from station 14+50 to 20+35 as part of cover system • Grading and compaction of embankment soils within section north of barrier wall from station 20+35 to 2+00 • Continued excavation and hauling of soil from western to eastern section of site as part of construction of BDA material storage vault • Installation of drainage pipe in sand layer along northern and western perimeter of cover system • Placement of Stoneway silt on top of barrier wall along southern section and between station 10+00 and 14+50 • Separation and stockpiling of cobbles near Stoneway borrow area using cobble sieve apparatus • Corrective actions for bentonite slurry discharge to Queen City Lake[(c)]
23 - 27 September 1996	• Continued sorting of cobbles near Stoneway borrow area • Excavation of storage vault for placement of BDA material in southwestern section • Preparation of subgrade for placement of geosynthetic clay liner (GCL) from station 20+35 to 2+50 • Discing of cover system subgrade soil and silt to accelerate drying and enhance compactibility in southwestern portion of cover system area • Placement and grading of cobbles from station 14+50 to 15+50 (approximately) • Placement of BDA soil in storage vault in western section of site • General site grading • Mixing portland cement with bentonite slurry in southern impoundment pond to stabilize excess slurry for placement onsite
30 September - 4 October 1996	• Compaction and placement of clean soil cover over BDA soil • Grading silt cover over barrier wall along southern section • Placement of cobbles between stations 15+00 and 20+35 • SME stabilization of contaminated soil unearthed during working platform construction near station 18+97 and subsequently stockpiled near the BDA pile • Excavation of silty sand and gravel from onsite location for use as cover system top layer • Placement of sand/gravel layer over cobbles on northern section of cover system area • General site grading • Preparation of subgrade for GCL placement as part of cover system from station 0+00 to 4+00
7 - 11 October 1996	• Placement of GCL and PVC liner from station 20+35 to approximately 4+50 • Placement of sand between stations 20+35 and 21+25 as part of cover system

Dates	Activity
7 - 11 October 1996 (Continued)	• Placement of cobbles between stations 20+35 and 21+25 as part of cover system • SME stabilization of contaminated soil unearthed during working platform construction near station 18+97 and subsequently stockpiled near the BDA pile • Preparation of subgrade to approximately station 12+15 for GCL and PVC liner • General site grading
14 - 18 October 1996	• Placement of GCL and PVC liner near station 12+60 (approximately) • Placement of sand near station 4+50 • Placement of cobbles near station 2+00 • Placement of sand/gravel top course to station 0+75 and 12+60 (approximately) • Completion by SME of stabilization of contaminated soil and placement of stabilized soils in storage vault in southwestern section • Grading southwest section of site for GCL and PVC liner
21 - 25 October 1996	• Completion of cover (sand, cobbles, and sand/gravel layer) placed to 4+50 and 12+50 • Mixing kiln dust with water-saturated soil and trench spoil material • General improvements to site erosion control features • Grading southwest section of site along outside of barrier wall to improve drainage as per design
28 October - 1 November 1996	• Completion of placement of GCL and PVC liner as part of cover system • Placement of sand in southwest section of site as part of cover system • Grading site to improve drainage as per design • Improvements to site erosion control features (construction of runoff holding ponds, installation of corrugated half-pipe sections to collect runoff, and additional straw bales) as necessary to maintain proper function during heavy precipitation
4 - 8 November 1996	• Placement of sand over PVC liner in southwest section of site as part of cover system • Excavation of cobbles for cover system from Stoneway borrow area • General site grading • Shipment of K1466 excavator offsite
11 - 15 November 1996	• Placement of cobble layer over sand in southwestern section of cover system area • Placement of sand/gravel layer over cobble layer in western section of cover system area • Completion of excavation and separation of cobbles for cover system from Stoneway borrow area • Final grading in eastern section of site • Loading cobble sieve for shipment offsite

Dates	Activity
18 - 22 November 1996	• Completion of placement of cobbles as part of cover system • Spreading top layer soils • Collecting unsuitable top layer soils (for example, trench spoils) for placement in excavations • Preparing final grade over general site • Dismantling K1066 excavator and begin shipment offsite
25 - 29 November 1996	• Collection and disposal of unsuitable top layer soil into storage vaults • Mixing of excavation soils with kiln dust to stabilize general site placement and compaction • Completion of spreading top layer soil • Placement of top layer soil on eastern section of cover system
2 - 6 December 1996	• Dressing slopes adjacent to Queen City Lake and placement of rip rap along slope • Placement of erosion control mat in swales • General site grading • Closure and grading of water supply and former slurry mixing area • Repair of temporary drainage system (new straw bales and repairs to silt fence) along perimeter of project area worn by heavy precipitation and runoff • Installation of drainage system (pipes, catch basins) near southeast corner of VBW • Excavating sand and gravel from onsite location for use as top layer materials • Mixing kiln dust with water-saturated soil within general site area to stabilize general site placement and compaction • Placing cobbles for roadbed from station 2+00 towards well X-2
9 - 13 December 1996	• Continued installation of site drainage system components • Grading southwestern area of site and slope adjacent to Queen City Lake • Placement of rip rap on slope adjacent to Queen City Lake and at outfall energy dissipaters • Mixing of kiln dust with water-saturated soil within general site area to stabilize general site placement and compaction • Spraying mulch on northern portion of site for erosion control • Decontamination of equipment for removal offsite (dozers)
16 - 18 December 1996	• Spraying mulch on remainder of site • Decontamination of remaining equipment (excavators and dozer) • Demobilization

Dates	Activity
28 July - 1 August 1997	• Mobilization • Grading of drainage structures, access roads, monitoring well work pads • Completion of repair work on perforated drainage line along southern perimeter of cover system
4 - 8 August 1997	• Installation of drainage structures near "E" wells • General shaping of site slopes • Completion of repair work to Queen City Lake outlet culvert • Placement of crushed rock on access roads and work pads • General site cleanup
11-15 August 1997	• Re-working slope along Queen City Lake • Construction of drainage conduits for Stoneway silt pits • Surveying final grade contour and drainage within general site area • Demobilization
15 - 19 September 1997	• Hydroseeding

Notes:

(a) 17 May 1996: An unknown quantity of bentonite slurry in the barrier wall trench near station 16+30 discharged through the adjacent cobble layer to Queen City Lake. The cobble layer is part of the original cover installed as part of the IRM in 1986 (see Section 1.2). Hayward-Baker took the following corrective actions:
- Backfilled the cobble area with silty soil to prevent further discharge.
- Installed a silt fence in the vicinity of the discharge (this silt fence was in addition to the requirements presented in the project plans and specifications).
- Fortified the silt fence with straw bales.
- Removed the cobble layer from other areas of the project that also could have provided a conduit for discharge of the bentonite slurry mix.

(b) 5 September 1996: An unknown quantity of bentonite slurry seeped through a natural conduit layer from the barrier wall trench near station 7+85 and discharged to Queen City Lake. Upon discovery, Hayward-Baker used heavy equipment to plug the identified slurry migration pathway, stopping the discharge.

(c) 16 September 1996: Heavy rain eroded a temporary storage basin located near Sta. 15+00 and allowed an unknown quantity of bentonite slurry to discharge to wetlands portion of Queen City Lake. The slurry flow stopped approximately 100 feet into the vegetated perimeter of the wetlands area. Hayward Baker took the following steps to halt the discharge:
- Recovered the slurry using pump and vacuum equipment to the maximum extent practicable.
- Increased the height of the storage pond walls and the wall thickness to improve the ability of the pond to retain slurry and handle heavy rainfall.
- Constructed an earthen berm parallel to the edge of the wetlands to protect against a future discharge.
- Fortified the silt fence surrounding Queen City Lake with additional fence posts and straw bales.

A wetlands scientist evaluated the release and determined that potential impacts to the wetlands ecosystem would be minimal (Lee & Associates 1996).

2.0 MODIFICATIONS

This section presents modifications to the JBWS plans and specifications (Kennedy/ Jenks Consultants 1996). Modifications included:

- Modifying the "Silt" specification (Specification Section 02200, 2.03).
- Modifying the "Sand" specification (Specification Section 02200, 2.04).
- Modifying the "Geomembrane Material" specification (Specification Section 02918, 2.01).
- Adding the "Geosynthetic Clay Liner" specification (Specification Section 02919).
- Extending the 6-inch drain pipe and relocating/adding cleanouts.
- Modifying grading and slope protection between Turning Points 5 and 6.
- Modifying the "Silty Sand and Gravel" specification (Specification Section 02200, 2.06).
- Modifying cleanout details for the 6-inch drain pipe.
- Realigning the barrier wall between stations 13+79 and 11+70.
- Modifying the monitoring well extension details.

- Adding the "Hydroseed" specifications (Specification Section 02270, 2.04).

- Modifying the "Cobble" specification (Specification Section 02200, 2.05).

The following sections describe and explain the reasons for these modifications.

2.1 SILT

This section presents modifications to Parts 2 and 3 of Specification Section 02200 of the TRD Report (see Modification Number 1, Appendix B). Silt material available from siltation basins at the Stoneway gravel pit, adjacent to the QCF site, was identified during design as a potential source of suitable material for the base layer of the cover system expansion. Samples of the "Stoneway silt" material were collected directly from a siltation basin and submitted to Hong West & Associates for laboratory testing during the design phase. Testing included moisture content [American Society for Testing and Materials (ASTM) D 2216], grain size analysis (ASTM D 422), Atterberg Limits (ASTM D 4318), moisture/density relationship (ASTM D 698), and soil-geosynthetic interaction (ASTM D 5321). The test results compared favorably with the specification for the "Mt. Baker silt" material originally used for the IRM cover system, and the values obtained were incorporated into the design analyses.

Grain size analysis of the Stoneway silt removed from the siltation basins and stockpiled during construction showed that 100 percent of the available material would not pass the #10 sieve, as originally specified. The oversized material was generally well-rounded gravel and smaller cobbles. However, this Stoneway silt met the intent of the specification, as it provided a:

- Stable foundation for placement of subsequent layers of cover material.

- Relatively "smooth" (or defect-free) surface for contact with the PVC geomembrane.

- Relatively low-permeability buffer material beneath the PVC geomembrane.

Section 02200 of the specifications was modified to allow use of the Stoneway silt. The specification remained consistent with the intent of the design for the extended cover system silt layer presented in the TRD Report.

2.2 SAND

This section addresses modifications to Part 2 of Specification Section 02200 of the TRD Report (see Modification Number 2, Appendix B). A well-graded sand available from the Stoneway gravel pit operation was identified as potentially suitable material for the drainage layer of the cover system expansion . Analysis of the grain size distribution (ASTM D 422) within a sample of this Stoneway sand showed that the percentage of particles retained on the #10 and 1/4" sieves exceeded those established in Specification Section 02200, Paragraph 2.04. The maximum particle size in the Stoneway sand sample was 3/8" minus.

The Stoneway sand was determined to be a stable, protective layer for the geomembrane and a suitable drainage material. In addition, it was determined that, once placed and rolled, the Stoneway material would meet the functional hydraulic conductivity and strength requirements of the cover system design.

Section 02200 of the specifications was modified to allow use of the Stoneway material. The specification remained consistent with the intent of the design for the extended cover system sand layer presented in the TRD Report.

2.3 PVC GEOMEMBRANE

This section addresses two issues relating to the PVC geomembrane used at the site. The first issue involved the surface texture of one side of the PVC geomembrane used

in the cover system expansion (see Modification Number 3, Appendix B). The second issue involved cross-slope orientation of PVC geomembrane field seams (see Modification Number 4, Appendix B).

2.3.1 PVC Material

Specification Section 02918, Paragraph 2.01, subparagraph C originally required PVC with a "chevron pattern" embossed on one side. According to the PVC manufacturer, "file finish" better described the surface of the specific PVC material tested during the VBWS design phase. This file finish was determined to be integral to the development of the geosynthetic/soil interface shear strength that was exhibited during the design phase testing. PVC geomembrane delivered to the site for the initial phase of cover system construction was calendered using a different press than that used to produce the geomembrane originally tested, and it had a "taffeta finish" that was different from the file finish of the original material. The taffeta finish PVC geomembrane material was used in construction of the new cover (within the northeast/east portion of the barrier wall) from approximately station 17+00 to station 21+35. This required that the specifications be modified to require that alternative material (i.e., PVC geomembrane with a surface texture other than file finish) be provided to the Engineer for evaluation. Limited use of the taffeta finish PVC geomembrane within the portion of the barrier wall described above was approved based on the following:

- The slopes upon which taffeta finish geomembrane was placed in the new cover area were generally 7:1 horizontal to vertical (H:V) or flatter. Revised analysis of the slope stability for this portion of the cover, assuming a 15-degree interface friction angle and 50 pounds per square foot (psf) interface adhesion, indicated that the new slope would be stable under static loading conditions and exhibit satisfactory resistance to permanent deformation under design earthquake loading. The interface friction angle and adhesion values used in the revised slope stability analysis were determined to be reasonable based on the characteristics of the silt and PVC taffeta finish.

- A portion of the original cover system was constructed using a smooth PVC geomembrane over a 5H:1V slope with an approximate 30-foot slope height. This provided empirical evidence that the cover system constructed using smooth PVC was stable on a slope substantially steeper than 7H:1V.

2.3.2 PVC Installation

Originally Line B of Subpart 2.01 of Specification Section 02918 of the TRD stated, in part, that the "Geomembrane will be of such length to allow installation from top to bottom of all slopes greater than 10 percent to avoid seaming cross slope." During installation of the geomembrane within the northeast portion of the VBWS, the geomembrane installer (Layfield Plastics) extended a section of the PVC geomembrane cover to the barrier wall (along the bottom of the newly covered slope at and adjacent to Turning Point 3) using a panel that is joined along a cross-slope field seam to the larger section of the upslope geomembrane. The maximum width (seam to toe of slope) of the smaller downslope geomembrane panel measured along the maximum slope was about 40 feet.

Based on EPA's concerns regarding the adequacy and uniformity of the geomembrane field seams, particularly the cross-slope field seam near Turning Point 3, Kennedy/Jenks Consultants reviewed Layfield Plastics' field seaming procedures and testing results and observed the field installation operation.

According to information provided by Layfield Plastics, the field seams at the Queen City Farms site meet the NSF Standard 54 PVC bonded field seam strength requirement of 28 lbs/in. The PVC slope inclination near Turning Point 3 is about 7H:1V (about 8 degrees). The static downslope shear stress acting in the welded seam area due to the weight of the overlying final cover soils was estimated to be on the order of 90 psf, or less than 1 pound per square inch (psi). Considering a 1-inch unit length of welded seam, the anticipated shear stresses acting on the bonded PVC liner seam

were estimated to be substantially below the required seam strength of 27 lbs/in and were not expected to compromise the integrity and performance of the cover system.

The specification was modified to permit seaming cross slope on slopes greater than 10 percent provided that "special inspections or testing" could be required and that the Design Engineer's approval was obtained.

2.4 GCL

A GCL was substituted for the silt layer component of the expanded cover system over a portion of the site, from approximately station 20+50 to 14+50 (see sheet XX in Appendix A and Modification Number 6, Appendix B). The GCL product and installation requirements were specified in a new Specification Section 02919. This GCL was substituted for the following reasons:

- Suitable natural silt became difficult to obtain. The original borrow pit source became unacceptable because of excessive oversized material. Potential sources of suitable natural silt had high moisture contents and would have required extensive periods of dry weather or mechanical drying to achieve the optimum moisture content. Because of unseasonably high rainfall, an adequate drying period could not be anticipated to meet the project schedule.

- Elimination of the 2 feet of natural silt provided adequate storage capacity for the additional contaminated soil excavated during the barrier wall work platform grading that was solidified without altering the original grading design concept.

- The GCL could be installed much faster than the natural silt, facilitating adherence to the project schedule.

Based on these reasons, Section 02919 was added to the specifications.

2.5 COBBLES

Cobble material excavated and screened offsite for the cover system did not meet the gradation specified in Specification Section 02200, paragraph 2.05. The material available from the screening operation was essentially a combination of the two alternative gradations specified. Since the material met the functional requirement for the cover, the modification was made to allow the use of the material for cover system construction (see Modification Number 5, Appendix B).

2.6 SILTY SAND AND GRAVEL

Tests of some soil placed as the top layer in the cover system showed that the soil did not meet the silty sand and gravel specification established in Specification Section 02200, paragraph 2.06A. However, the soil did meet the functional requirements of the cover material described in the TRD Report. The material specification was modified by adding paragraph 2.06B, which described the new gradation requirements for the cover material (see Modification Number 9, Appendix B).

2.7 EXTENSION OF 6-INCH DRAIN PIPE AND RELOCATION OF CLEAN-OUTS

The final cover grading was modified to slope uniformly to the south-southwest along the southern portion of the barrier wall alignment, thereby eliminating the southeast-to-northwest segment of drainage swale originally called for on the cover system (i.e., within the barrier wall alignment). In order to enhance drainage along the southern portion of the cover system, the 6-inch toe drain pipe was extended from station 0+00 to station 8+60 and a discharge to Queen City Lake constructed. Additional cleanouts were provided along this additional section of drain pipe.

The 6-inch toe drain pipe was also extended from station 15+65 to station 13+90 along the north side of the barrier wall. Cleanout locations were also modified along the north side toe drain.

A side clean-out designed to be located near station 15+75 was moved to an in-line cleanout. Instead of connecting to the half culvert near station 15+75, the north side toe drain pipe was connected to the manhole located near station 14+00. These drainage modifications are documented in Modification Number 7 (Appendix B).

2.8 GRADING AND SLOPE PROTECTION MODIFICATION

Due to concerns regarding the erosion potential of the embankment between the barrier wall and Queen City Lake from station 13+79 to 8+60, enhanced erosion control measures were specified. Rip rap was placed from the toe of the slope to approximately halfway up the slope. Erosion control mat and mulch were placed along the top half of the slope (see Modification Number 8, Appendix B).

2.9 CLEANOUT DETAIL MODIFICATION

Cleanout details 4 and 5 shown on Sheet C-10 in the TRD Report were modified to simplify construction by replacing the vertical sections of PVC pipe with corrugated polyethylene pipe (see Modification Number 10, Appendix B). The corrugated pipe specified was the same diameter as the horizontal drainage collection pipe. Concrete surrounding the vertical pipe sections was replaced with sand or gravel backfill. A neoprene boot was used to secure the PVC cleanout extension to the vertical corrugated pipe.

2.10 REALIGNMENT OF THE BARRIER WALL

The barrier wall trench between station 13+79 and station 11+70 (approximately) was constructed along a curved alignment instead of on the straight-line alignment segments originally shown on sheet C-2 in the TRD Report (see Memorandum from Kurt Hoppen to Project File dated 28 June 1996 in Appendix B). The curve enabled continuous trench construction without stopping to construct TP 6, station 12+43, using the typical Turning Point construction method.

The curved alignment is located outside the area enclosed by the designed centerline alignment originally shown on sheet C-2. Therefore, the constructed cover area was not reduced as a result of the trench realignment.

David Evans & Associates surveyed station offset lines north of the centerline on either side of station 12+43. Hayward Baker subdivided the offset lines into 10-foot intervals to establish the locations for assessing the trench depth.

The curved alignment was approximately 20 feet shorter than the original design alignment. Station correction equations were used to calculate locations at the beginning and end of the curve (station 13+79 and station 11+70, approximately). The equations accounted for the actual length along the curve without changing other stations of the trench sections constructed along the design centerline.

2.11 WORKING PLATFORM ELEVATION

During barrier wall construction, the elevations of some of the working platforms varied from those shown on the TRD drawings. Elevation adjustments were made based on field conditions to facilitate slurry trench excavation. These variations were anticipated and were permitted under the original design (see Note 2 on sheet C-5 and Note 4 on sheet C-4). Record drawings of the final wall top elevations and cover system tie-in are shown in the TRD drawings (Appendix A).

2.12 MONITORING WELL EXTENSION MODIFICATION

The method for extending site monitoring wells was slightly modified by using two couplings instead of a single rubber boot as originally designed (see Shop Drawing Review Letter from Kurt Hoppen to Chris Kovac dated 9 July 1996 and in Appendix B). The modified method adequately protected the PVC slip fit coupling and simplified installation.

2.13 HYDROSEEDING MODIFICATION

The seed mix and fertilizer specification of Section 02270 of the TRD were modified at the request of Terra Dynamics, Inc. (hydroseeding subcontractor), based upon an analysis of site-specific soil conditions. The seeding modifications were consistent with the intent of the seeding requirements of Section 02270 of the TRD (see Modification Number 11, Appendix B).

3.0 PERFORMANCE STANDARDS AND ASSESSMENT

This section describes the performance standards for the barrier wall and associated work identified in the CD SOW (EPA 1993) and the TRD Report (Kennedy/Jenks Consultants 1996). This section also provides an evaluation of the compliance of the RA with these performance standards.

3.1 BARRIER WALL

3.1.1 Performance Standards

The following performance standards for the barrier wall were established in the CD and the TRD:

- The wall shall be installed to isolate the IRM area and areas where LNAPL have been detected.
- The wall shall be keyed into the aquitard system beneath Aquifer 1, where present.
- The barrier shall have a permeability of not greater than 10^{-7} centimeters per second (cm/sec) and shall be continuous in order to prohibit "windows" of higher permeability.
- The barrier wall and backfill shall be stable and resistant to degradation from hydraulic permeation of the wall and from adjacent groundwater movement.
- The barrier wall shall maintain integrity and physical stability under environmental loading conditions such as seismic events and/or dewatering of the interior formation.

- The barrier wall shall retain long-term integrity under possible chemical alterations.

The barrier wall construction materials were also evaluated in accordance with quality control requirements identified in the specifications (see the TRD Report, Appendix C, Specification Section 02910). These specifications required the collection and evaluation of data on the following parameters:

Item	Parameter
Mix Water	• pH • Hardness
Bentonite	• Compliance with API Standard 13A
Pond Slurry	• Viscosity • Unit Weight • Filtrate Loss
Trench Slurry	• Viscosity • Unit Weight
Backfill	• Permeability • Fines Content • Unit Weight • Slump • Slope Profile
Trench	• Depth • Key

3.1.2 Compliance With Performance Standards

Location and Depth. The barrier wall was installed in accordance with the plans and specifications contained in the TRD Report, except as modified as described in Sections 2.10 and 2.11. Golder Associates provided independent observation of the barrier wall construction and collected detailed data on the depth of the wall excavation. Both the RA contractor and Golder Associates evaluated excavated materials to assess whether excavation had satisfactorily penetrated the aquitard system (where present), as described in the plans. Appendix A contains the record drawings, including construction modifications.

Permeability and Continuity. Permeability and other physical characteristics of the SB mix were assessed periodically in accordance with the TRD Report, Appendix C, Specification Section 02910. Table 3-1 presents the analytical results.

Stability and Resistance to Groundwater Movement and Dewatering. Section 2.2.4 of the TRD Report contained an assessment of the stability of the barrier wall based on potential post-construction hydraulic conditions. The barrier wall was constructed to specifications identified in the TRD Report. On the basis of the design analysis, the barrier wall will exhibit stability and resistance to degradation from hydraulic permeation and adjacent groundwater movement.

Stability During Seismic Events. Section 2.2.6 of the TRD Report addressed the stability of the barrier wall under stresses induced by a seismic event. The barrier wall was constructed to specifications identified in the TRD Report and is designed to be stable during the design seismic event.

Long-Term Integrity. Appendix B of the TRD Report contained an assessment of the potential effects of chemicals in site soil and groundwater on the long-term integrity of the barrier wall. In summary, the SB barrier wall is expected to retain satisfactory long-term integrity under possible chemical alterations resulting from permeating groundwater and chemical constituents in the soils and groundwater incorporated into the backfill.

Specification Requirements. The pH and hardness of the mix water were tested and met the specification requirements. Bentonite suppliers furnished compliance certificates for deliveries of bentonite in accordance with the specifications. Table 3-2 presents quality control data for the pond slurry and trench slurry. The adequacy of the penetration (keying) of the barrier wall into appropriate geologic formations was verified through the concurrence of the RA contractor, Design Engineer, The Boeing Company, Golder Associates, and the EPA on wall completion depths.

TABLE 3-1

SOIL-BENTONITE BACKFILL DATA

Sample ID	Date Sampled	Sample Description	Sample Location	Backfill Data[a]			
				Unit Weight (pcf)	Permeability (cm/sec)	Fines (%)	Slump[b] (in)
			Specification Requirement	15 pcf > trench slurry	1*10-7	>20% passing #200 sieve	3-7
S-1	5/8/96	Stockpiled Excavation Spoils	Excavation Stockpile	NR	NR	48.1	NR
S-2	5/9/96	Slurry Trench Spoils	Upper Mixing Cell	143.2	2.2*10-6	24.5	NR
S-3	5/9/96	Unmixed Backfill	Upper Mixing Cell	137.2	6.9*10-7	37.2	NR
S-4	5/12/96	Unmixed Backfill	Upper Mixing Cell	135.1	9.0*10-7	31.9	NR
S-5	5/14/96	Unmixed Backfill	Upper Mixing Cell	133.4	6.6*10-7	24.4	8
S-6	5/15/96	Unmixed Backfill	Upper Mixing Cell	129.3	4.8*10-7	35.6	5
S-7	5/16/96	Mixed Backfill	Lower Mixing Cell	117.9	1.2*10-8	37.3	5
S-8	5/16/96	Mixed Backfill	Lower Mixing Cell	132.1	2.8*10-8	36.9	3
S-9	5/29/96	Mixed Backfill	Lower Mixing Cell	129.4	2.2*10-8	24.1	3
S-10	5/31/96	Mixed Backfill	Lower Mixing Cell	122.3	2.0*10-8	31.8	6.5
S-11	6/18/96	Mixed Backfill	Lower Mixing Cell	122.5	7.5*10-8	47.6	3.5
S-13	6/26/96	Mixed Backfill	Lower Mixing Cell	122.3	6.3*10-8	48.6	6
S-16	7/3/96	Mixed Backfill	Lower Mixing Cell	122.2	2.4*10-8	41.0	4
S-23	8/2/96	Mixed Backfill	Lower Mixing Cell	122.1	3.3*10-8	39.8	3.5
S-28	8/12/96	Mixed Backfill	Lower Mixing Cell	126.1	2.9*10-8	30.6	4
S-29	8/14/96	Mixed Backfill	Lower Mixing Cell	123.0	1.2*10-8	29.0	4.5
S-31	8/19/96	Mixed Backfill	Lower Mixing Cell	126.0	3.0*10-8	27.5	3.5
S-33	8/28/96	Mixed Backfill	Lower Mixing Cell	128.9	2.0*10-8	25.5	4.5
S-36	9/4/96	Mixed Backfill	Lower Mixing Cell	130.5	1.9*10-8	17.9	5.5
S-37	9/9/96	Mixed Backfill	Lower Mixing Cell	121.5	3.2*10-8	28.5	3.5
S-38	9/9/96	Mixed Backfill	Lower Mixing Cell	118.5	4.5*10-8	34.3	3
S-39	9/10/96	Mixed Backfill	Lower Mixing Cell	117.4	9.7*10-9	31.2	4.5
S-40	9/11/96	Mixed Backfill	Lower Mixing Cell	119.4	1.2*10-8	32.8	4

Notes:

(a) For samples S-7 to S-40, fines content is from the original sample. Permeability and unit weight data are from the remolded samples. Remolding was required to run the permeability tests (ASTM D-5084).

(b) Slump data were collected in the field and recorded in a notebook.

NR - Not Required

TABLE 3-2

POND SLURRY AND TRENCH SLURRY QUALITY CONTROL DATA

Date	Pond Slurry			Trench Slurry				Corrective Action Taken
	Viscosity (sec)	Unit Weight (pcf)	Filtrate Loss (cc/30 min @ 100 psi)	Viscosity #1 (sec)	Unit Weight #1 (pcf)	Viscosity #2 (sec)	Unit Weight #2 (pcf)	
Specification Requirement	>40	>64	<25	>40	>64	>40	>64	
5/7/96	45	ND	ND	ND	67.3	ND	67.1	NR
5/8/96	51	65.0	ND	55	76.0	51	67.0	NR
5/9/96	45	65.5	13.0	54	75.0	53	65.0	NR
5/10/96	45	65.2	12.7	56	74.0	ND	ND	NR
5/13/96	45	65.5	13.5	42	71.2	45	72.0	NR
5/14/96	45	65.0	ND	39	71.0	43	70.5	Added bentonite
5/15/96	45	65.0	ND	41	69.2	42	70.8	NR
5/16/96	43	65.5	13.0	42	70.0	43	70.8	NR
5/17/96	60	65.0	ND	42	70.8	ND	ND	NR
5/20/96	46	65.0	ND	41	65.5	ND	ND	NR
5/21/96	46	65.2	13.0	42	69.8	45	70.5	NR
5/22/96	46	65.2	ND	44	69.5	45	72.0	NR
5/23/96	44	65.0	ND	48	71.2	ND	ND	NR
5/24/96	46	65.0	ND	51	75.0	46	71.0	NR
5/28/96	40	64.5	15.3	48	72.5	46	75.5	NR
5/29/96	45	64.8	ND	51	77.4	53	74.5	NR
5/30/96	41	68.2	13.0	53	74.0	57	75.0	NR
5/31/96	41	71.3	ND	53	74.0	51	77.9	NR
6/3/96	41	64.5	16.5	49	74.3	51	75.5	NR
6/4/96	41	66.0	ND	53	76.1	54	76.0	NR
6/5/96	40	65.5	ND	54	75.8	58	76.6	NR
6/6/96	40	65.0	14.2	55	76.0	56	77.0	NR
6/7/96	41	65.9	ND	58	75.0	60	76.2	NR
6/10/96	40	65.5	14.5	58	77.6	58	77.8	NR
6/11/96	41	65.5	ND	57	80.0	58	81.1	NR
6/12/96	41	66.0	ND	60	80.5	61	81.0	NR
6/13/96	41	65.5	18.5	63	80.4	65	81.0	NR
6/14/96	51	65.2	ND	60	80.5	61	80.5	NR
6/17/96	49	65.0	13.5	66	83.0	66	83.0	NR
6/18/96	51	68.8	ND	65	82.0	66	83.0	NR
6/19/96	47	64.5	ND	68	83.8	65	84.2	NR
6/20/96	47	64.7	9.0	68	94.0	69	94.5	NR
6/21/96	47	65.0	ND	53	82.5	55	83.0	NR
6/24/96	47	64.8	14.8	51	86.8	54	87.5	NR
6/25/96	47	64.9	ND	53	84.1	55	85.0	NR
6/26/96	43	66.2	ND	55	72.0	57	73.2	NR
6/27/96	47	68.6	14.2	52	73.5	56	74.8	NR
6/28/96	45	65.0	ND	52	70.1	55	71.3	NR
7/1/96	41	64.5	18.5	47	71.5	51	73.2	NR
7/2/96	71	64.9	ND	47	66.2	53	68.4	NR
7/3/96	68	64.9	ND	50	67.0	52	67.8	NR
7/8/96	64	65.3	14.5	48	66.5	44	68.2	NR

TABLE 3-2

POND SLURRY AND TRENCH SLURRY QUALITY CONTROL DATA

Date	Pond Slurry			Trench Slurry				Corrective Action Taken
	Viscosity (sec)	Unit Weight (pcf)	Filtrate Loss (cc/30 min @ 100 psi)	Viscosity #1 (sec)	Unit Weight #1 (pcf)	Viscosity #2 (sec)	Unit Weight #2 (pcf)	
Specification Requirement	>40	>64	<25	>40	>64	>40	>64	
7/9/96	42	64.9	ND	50	68.2	51	69.0	NR
7/10/96	40	64.6	ND	48	67.3	51	68.1	NR
7/11/96	40	64.8	13.5	47	67.5	51	69.0	NR
7/12/96	40	64.7	ND	43	66.8	46	68.3	NR
7/15/96	55	64.9	15.0	44	66.7	48	69.2	NR
7/16/96	59	65.0	ND	44	66.1	46	66.9	NR
7/17/96	49	64.9	ND	44	66.5	50	67.8	NR
7/18/96	50	65.0	14.0	50	71.9	53	74.0	NR
7/19/96	105	65.1	ND	48	69.3	52	70.9	NR
7/22/96	NSA	NSA	ND	52	71.9	57	74.0	NR
7/23/96	47	64.6	ND	49	65.3	52	67.0	NR
7/24/96	42	64.2	15.8	42	65.1	47	69.2	NR
7/25/96	40	64.5	15.5	41	65.9	51	67.1	NR
7/26/96	44	64.7	ND	45	66.5	47	68.6	NR
7/29/96	44	64.8	ND	47	67.3	52	68.9	NR
7/30/96	49	65.0	ND	43	69.5	47	70.3	NR
7/31/96	44	64.8	ND	47	70.1	52	71.3	NR
8/1/96	42	64.1	15.5	48	67.1	53	69.9	NR
8/2/96	42	64.8	ND	48	67.8	53	69.4	NR
8/5/96	48	64.9	16.5	53	68.0	60	71.6	NR
8/6/96	42	64.8	ND	53	68.5	60	71.9	NR
8/7/96	43	64.5	ND	56	69.3	52	71.6	NR
8/8/96	40	64.2	16.4	52	69.0	56	70.8	NR
8/9/96	NSA	NSA	ND	78	71.2	94	71.8	NR
8/12/96	40	64.4	16.5	74	71.0	82	71.8	NR
8/13/96	40	64.2	ND	40	64.5	62	70.8	NR
8/14/96	40	64.3	ND	44	65.1	60	70.1	NR
8/15/96	41	64.4	15.5	43	65.0	49	65.8	NR
8/16/96	40	64.3	ND	48	65.8	44	66.1	NR
8/19/96	41	64.2	15.7	43	65.4	47	66.0	NR
8/20/96	40	64.3	ND	40	65.0	46	65.5	NR
8/21/96	41	64.4	ND	43	65.5	47	65.8	NR
8/22/96	43	64.5	10.5	42	65.8	41	66.7	NR
8/23/96	41	64.2	ND	48	65.1	59	69.7	NR
8/26/96	41	64.8	15.0	48	66.3	64	69.5	NR
8/27/96	41	64.4	ND	50	68.2	62	70.1	NR
8/28/96	40	64.3	ND	50	69.8	47	73.2	NR
8/29/96	40	64.2	15.8	52	71.8	46	75.0	NR
8/30/96	40	64.0	ND	51	71.5	80	73.2	NR
9/3/96	41	64.8	15.2	52	71.0	50	72.5	NR
9/4/96	41	64.4	ND	50	69.9	49	70.5	NR
9/5/96	42	64.6	ND	51	68.0	53	70.1	NR
9/6/96	NSA	NSA	ND	50	68.2	48	70.5	NR

TABLE 3-2

POND SLURRY AND TRENCH SLURRY QUALITY CONTROL DATA

Date	Pond Slurry			Trench Slurry				Corrective Action Taken
	Viscosity (sec)	Unit Weight (pcf)	Filtrate Loss (cc/30 min @ 100 psi)	Viscosity #1 (sec)	Unit Weight #1 (pcf)	Viscosity #2 (sec)	Unit Weight #2 (pcf)	
Specification Requirement	>40	>64	<25	>40	>64	>40	>64	
9/9/96	NSA	NSA	ND	48	68.8	50	69.6	NR
9/10/96	NSA	NSA	ND	63	77.4	ND	ND	NR

Notes:

(a) For samples S-7 to S-40, fines content is from the original sample. Permeability and unit weight data are from the remolded samples. Remolding was required to run the permeability tests (ASTM D-5084).
(b) Slump data were collected in the field and recorded in a notebook.
ND - Not detected
NR - Not required
NSA - No slurry available

3.2 COVER SYSTEM

3.2.1 Performance Standards

The performance standards established in the CD and TRD for the cover system expansion are listed below. The expansion of the cover system shall:

- Be compatible with the existing cover system.
- Provide long-term minimization of infiltration throughout the expanded IRM area.
- Function with minimum maintenance.
- Promote drainage and minimize erosion or abrasion of the cover system material.
- Accommodate settling and subsidence so that the cover system's integrity is maintained.

3.2.2 Compliance With Performance Standards

Compatibility. The expanded cover system used materials and lift dimensions similar to those used in construction of the existing IRM cover system. The GCL installed in place of silt is compatible with the silt layer (in terms of function and connection to the silt layer) and the other cover components.

Long-Term Minimization of Infiltration. Chemical migration would likely be the result of substantial surface water infiltration. The cover was designed to minimize surface water infiltration by using:

- Grading and a surface water collection system that promote surface water runoff to Queen City Lake.

- A vegetative cover that reduces infiltration and promotes soil moisture storage and evapotranspiration.

- A synthetic liner and silt layer (or GCL) that impede stormwater infiltration into the underlying soil. The synthetic liner and silt (or GCL) combined with the underdrain system are designed to efficiently convey seepage off the cover system to reduce infiltration potential.

Maintenance Requirements. The cover system was designed to function with minimum maintenance. O & M requirements for the cover system described in Section 4.0 are not significant.

Drainage and Minimization of Erosion or Abrasion. The cover system was constructed to promote stormwater runoff. Slopes are typically gentle enough to minimize erosion in conjunction with the vegetative cover. Erosion control mat, rip rap, improved drainage swales, and culverts were provided to minimize erosion.

Accommodation of Settling and Subsidence. Settling and subsidence are not expected to significantly affect the integrity of the expanded cover system (i.e., damage the synthetic liner or silt layer). Most cover subsidence is caused by collapse of voids in underlying waste material (EPA 1990). The material underlying the cover system is clean fill, soil from the BDA, or geosynthetic material. Because soil was compacted in accordance with the project specifications and the geosynthetic materials were properly installed, settling and subsidence to degrees that are potentially detrimental to the integrity of the cover are not expected.

Specifications. The cover system was evaluated in accordance with quality control requirements presented in the specification (see the TRD Report, Appendix C, Specification Sections 02200 and 02918) and met the specification requirements.

Changes in the specifications made during construction are described and justified in Section 2.0 of this Report.

3.3 DRAINAGE SYSTEM

3.3.1 Performance Standards

The technical performance standards presented in the CD for the drainage system include the following:

- The drainage system shall be integrated with existing drainage features, and the existing features shall be modified as necessary to accommodate anticipated changes in flow.

- The drainage system shall be reliable and shall function without excessive maintenance.

- The drainage system shall convey runoff to the Queen City Lake or the Main Gravel Pit Lake.

3.3.2 Compliance With Performance Standards

Integration with Existing System. The drainage system was designed to complement the existing drainage system. Additions to the existing drainage system included drainage swales and underdrains sized appropriately to collect surface water and seepage for discharge to Queen City Lake.

Maintenance Requirements. The drainage system was designed to function with minimum maintenance. O & M requirements for the drainage system are described in Section 4.0.

Drainage to Queen City Lake. The cover system was designed to drain to Queen City Lake (see drawing C-9 in Appendix A).

Specifications. The drainage system was evaluated in accordance with quality control requirements presented in the specifications (see the TRD Report, Appendix C, Specification Sections 02200 and 02918) and met the specification requirements. Changes in the performance specifications are described and explained in Section 2.0 of this Report.

4.0 OPERATIONS AND MAINTENANCE

This section presents the O&M Plan for the VBWS.

4.1 INSTRUCTION AND USER'S GUIDE

4.1.1 Facility Description

The VBWS at the site consists of three elements: (1) a vertical, 3- to 4-foot-wide SB barrier wall installed to isolate residual contaminated soil; (2) an expanded cover system over the area enclosed by the SB wall; and (3) a surface drainage system.

4.1.2 User's Guide

This O&M Plan provides:

- Guidance for periodic site inspections.
- Descriptions of potential corrective actions.

The As-Built Record Drawings for the VBWS (Appendix A) describe the materials of construction, the configurations, and the functions of the various system components.

Most elements of the routine O&M Plan inspections can physically be undertaken by one person; however, a two-person inspection team is generally recommended for safety. Do not enter culverts, manholes, or catch basins without proper entry monitoring and safety personnel. Specific corrective action requirements will be developed based on the findings of the periodic monitoring events. Most maintenance is generally expected to require only hand tools and common earth-moving equipment.

4.2 ROUTINE O&M

Routine O&M consists of inspecting the site, assessing potential changes in site conditions that may adversely impact proper functioning of the VBWS, and correcting deficiencies. Routine O&M involves:

- **Security** - Inspect for signs of unauthorized entry, vandalism, or compromise of the site perimeter fence integrity.

- **Cover** - Inspect for deterioration, vandalism, or other damage to the cover. Examine slopes for erosion, sliding, sloughing, cracking, or other signs of failure that may reduce the cover's effectiveness. Identify eroded areas or distressed vegetation on cover.

- **Drainage system** - Inspect, test, and identify damaged, crushed, or clogged drainage courses. Visually assess accumulated material in catch basins and siltation barriers.

- **Barrier Wall Maintenance** - Because the cover system conceals the barrier wall, no inspections other than possible settlement inferred from ground subsidence are anticipated. Wall performance will be evaluated based on the results of groundwater level measurements and quality monitoring.

O&M activities will begin after final inspection of the completed VBWS. The Boeing Company O&M personnel will visit the site monthly for the first 2 years and semiannually for the duration of the O&M period. Additional visits will occur after a 25-year, 24-hour storm event (3.6 inches of rainfall) or greater.

Table 4-1 summarizes the inspection/maintenance schedule for the site. Table 4-2 presents a checklist of typical supplies that will be needed for each inspection. An O&M inspection report form is presented in Table 4-3.

TABLE 4-1

INSPECTION/MAINTENANCE SCHEDULE

System	Item	Frequency	Potential Defect	Repair
Site conditions	Surface	Monthly[(a)]; after 25-year, 24-hour storm event	Accumulation of water, erosion features, subsidence	Repair structural degradation with soil and additional vegetation
	Vegetation	Monthly[(a)]	Disturbed benchmarks	Replace/resurvey benchmarks
			Vegetation overgrowth	Remove saplings
Site security	Fences, gates	Monthly[(a)]; after 25-year, 24-hour storm event	Deterioration; vandalism	Replace defective section
			Locks missing/inoperable	Replace lock
			Signs destroyed	Replace signs
Drainage system	Drainage pipes/culverts	Monthly[(a)]; after 25-year, 24-hour storm event	Cracked or leaking pipes	Replace defective pipe sections
			Clogged drainage material	Flush or replace drainage material
	Underdrain pipes	Monthly[(a)]; after 25-year, 24-hour storm event	Sedimentation clogging	Vacuum and flush pipe
	Discharge points	Monthly[(a)]; after 25-year, 24-hour storm event	Pooling or standing water	Regrade or excavate
Cover system	Cover	Monthly[(a)]; after 25-year, 24-hour storm event	Erosion, settlement	Replace with proper geotechnical material; replace lost soil and revegetate
	Side slopes	Monthly[(a)]; after 25-year, 24-hour storm event	Damage caused by burrowing animals, vegetation growth, or seismic activity	Replace damaged areas; re-evaluate vegetation cover
			Sliding or sloughing	Replace or mix weak soil with selected material; place fill material on toe; drain

Note:

(a) Monthly for the first two years and semiannually for remaining O&M period.

TABLE 4-2

INSPECTION SUPPLIES CHECKLIST

SUPPLIES
Plan Set
Camera and Film
Measuring Rod
Measuring Tape
Orange Spray Paint
Lath and Surveyor's Ribbon
Traffic Posts and Caution Tape
Water Sounding Device
Assorted Tools (wrenches, hammer, screw driver, etc.)
Hose and Water Supply for Annual Underdrain Check
Waterproof Notebook and Pen
Personal Protective Equipment (as appropriate)
First Aid Kit
Flash Light
Health & Safety Plan
Inspection Form
Confined Space Entry Equipment (if appropriate) Extraction Harness and Rope Air Monitoring Instrumentation

TABLE 4-3

O&M INSPECTION REPORT
QUEEN CITY FARMS
VERTICAL BARRIER WALL SYSTEM
OPERATION AND MAINTENANCE

Inspection Date: _____

Personnel: _____

ITEM	ITEMS TO MEASURE OR NOTE	OBSERVED CONDITIONS/MEASUREMENT	MAINTENANCE OR CORRECTIVE ACTION REQUIRED
1. Site Conditions			
Accumulation of water	If present, where?		
Erosion	If present, where?		
Subsidence	If present, where?		
Fissures	If present, where?		
Disturbed benchmarks	Which benchmarks are disturbed?		
Vegetation Overgrowth	If present, where?		
2. Site Security			
Fences	Location of deterioration or vandalism		
Gates	Are gates operable?		
Locks	Missing or not functioning?		
Signs	Signs destroyed or vandalized?		

TABLE 4-3

O&M INSPECTION REPORT
QUEEN CITY FARMS
VERTICAL BARRIER WALL SYSTEM
OPERATION AND MAINTENANCE

Inspection Date: _____

Personnel: _____

ITEM	ITEMS TO MEASURE OR NOTE	OBSERVED CONDITIONS/MEASUREMENT	MAINTENANCE OR CORRECTIVE ACTION REQUIRED
3. Drainage System			
Central Surface Drainage System 18" half culvert that runs east-west down the center of the west half of the cover.	Range of depth of sediment accumulation. Area and depth of high sediment build-up.		
6.5' swale south of the central 18" half culvert that runs parallel and then turns to connect to the half culvert.	Range of depth of sediment accumulation. Area and depth of high sediment build up.		
Catch basin at intersection of swale and half culvert near Queen City Lake.	Depth of sediment		
Central Subsurface Drainage System A 6" perforated corrugated pipe runs approximately the same path as the half culvert and the swale and discharges into same catch basin. Pour clean water into the cleanout for the north subsurface drain and observe flow at discharge.	Does water flow freely?		
Pour clean water into the cleanout closest to the catch basin for the south subsurface drain and observe flow at discharge.	Does water flow freely?		

O&M INSPECTION REPORT
QUEEN CITY FARMS
VERTICAL BARRIER WALL SYSTEM
OPERATION AND MAINTENANCE

Inspection Date: _____

Personnel: _____

ITEM	ITEMS TO MEASURE OR NOTE	OBSERVED CONDITIONS/MEASUREMENT	MAINTENANCE OR CORRECTIVE ACTION REQUIRED
South Surface Drainage System 10' swale at south side of cover system.	Range of depth of sediment accumulation. Area and depth of high sediment build-up.		
Culvert inlet structure from swale.	Depth of sediment at entrance and in pipe.		
Pour clean water into culvert manhole and observe flow at discharge.	Does water flow freely?		
Culvert manhole.	Sediment depth?		
North and East Surface Drainage System Catch basin cover at southeast corner of cover.	Sediment depth?		
6.5' swale that wraps around east end of cover system west of steeper grade and parallel swale.	Range of depth of sediment accumulation. Area and depth of high sediment build-up.		
6.5' swale that extends from the southeast corner of the cover to the middle of the north side.	Range of depth of sediment accumulation. Area and depth of high sediment build-up.		
North and East Subsurface Drainage System A 6" perforated PE pipe extends from the catch basin at the southeast corner of the cover system around the cover to the north central end of the cover and discharges into the half culvert.			

O&M INSPECTION REPORT
QUEEN CITY FARMS
VERTICAL BARRIER WALL SYSTEM
OPERATION AND MAINTENANCE

Inspection Date: _____

Personnel: _____

ITEM	ITEMS TO MEASURE OR NOTE	OBSERVED CONDITIONS/MEASUREMENT	MAINTENANCE OR CORRECTIVE ACTION REQUIRED
Pour clean water into cleanout closest to discharge to half culvert, and observe flow at discharge.	Does water flow freely?		
A 12" PVC pipe runs parallel to the north side of the cover system and discharges into Queen City Lake.	Condition of energy dissipator?		
Catch basin and manhole near northwest corner of cover system	Sediment Depth?		
4. Cover system			
Settlement	If present, where?		
Damage caused by burrowing animals	If present, where?		
Fissures	If present, where?		
Side slopes sliding or sloughing	If present, where?		
Seismic activity damage	If present, where?		

Frequency: All items shall be performed monthly for the first two years and semiannually thereafter, and after each 25-year, 24-hour storm event (3.6 inches of rainfall).

4.3 SECURITY MAINTENANCE

The site perimeter fence will be inspected and maintained. The inspector will walk along the fence line and check for loose fencing and poles and assess the overall condition of the fence. Deteriorated or vandalized fencing will be replaced, and fence fabric will be tied securely. Loose fence poles will be identified for replacement or repair. The gates will be inspected for integrity. Problems noted during the inspections will be documented in the O&M report.

4.4 COVER MAINTENANCE

4.4.1 Vegetation

The site is vegetated to minimize erosion. The site was seeded with low- growing grasses with shallow root. The cobble layer under the vegetative cover layer is intended to prevent deep root systems from penetrating the cover and to prevent burrowing animals from damaging the cover.

Over time, the deep root systems of larger indigenous plant species could penetrate the cobbles and compromise the cover. Therefore, these larger indigenous species must not be allowed to grow on the cover. Vegetation maintenance will include the removal of saplings and other large plant species.

Areas of the cover system where vegetation becomes distressed, dies (other than annual cycles) or is removed by erosion will be restored by adding silty sand and gravel (as needed) and reseeding according to the original specifications. Problem areas may require supplemental erosion protection to ensure a durable vegetative cover. Watering is not required, except to help establish revegetated areas.

4.4.2 Erosion

The cover and drainage swales will be inspected for signs of excessive erosion that may expose underlying material (i.e. cobble layer), permit excessive infiltration of stormwater, or promote continued erosion (i.e. lead to exposure of the PVC geomembrane). The side slopes of the cover system will be inspected to confirm slope stability. Possible slope failure may be indicated by downward movement (sliding or sloughing) of the soil. If slope failure is detected during site visits, the area affected will be roped off immediately to prevent access to the area. Eroded or damaged areas will be repaired to restore the cover system to its original condition.

4.4.3 Settlement

The cover system is not expected to experience significant differential settlement. Excessive differential settlement may result from consolidation of the fill material, which would damage the cover system components. A relative vertical displacement sufficient to crack the surface between two adjoining areas of the cover will be considered excessive and detrimental. Areas and amounts of settlement will be noted during each site inspection. Corrective actions, such as repair or replacement of the cover in the areas of settlement, will be taken if settlement that is potentially detrimental to the cover system performance should develop.

4.4.4 Seismic Damage

Following seismic activity, the cover system will be inspected for cracking and slope failure. Damaged areas will be repaired to restore the cover system to its original condition.

4.5 DRAINAGE SYSTEM MAINTENANCE

Stormwater drainage systems will be inspected to ensure proper functioning. Swales or berms over and adjacent to the cover system will be inspected for signs of erosion, sedimentation, or blockages that may require corrective actions. Following storm events, drainage pipe outlets will be observed for ponding or inadequate drainage that may cause water to back up into the pipe.

Catch basins and manholes will be inspected for accumulated debris and will be cleaned out when appreciable debris/sediment accumulation is noted. Culverts will be checked for cracks or leaks and repaired or replaced as appropriate.

Cobble/silt barriers along the cover and perimeter drainage swales will be inspected for silt accumulation and cleaned out periodically to assure proper function.

Each underdrain will be tested by discharging water into the cleanout nearest to the drain discharge, flooding the underdrain with clean water, and checking the underdrain discharge to assure that it is flowing. Blocked or severely constricted underdrains will be cleaned out either by flushing or using a rotary mechanical clearing device.

4.6 RECORDS AND CORRECTIVE ACTION

O&M activities, including the results and observations of each O&M inspection, will be recorded and maintained by The Boeing Company. O&M reports will document the following:

- Observations made during scheduled inspections. The conditions, measurements, and actions taken during the inspections will be recorded.

- Changes in site condition from previous site visits.

- Maintenance and corrective actions implemented.

- Photographs from the following locations:
  - From the top of the east cut bank looking from VBWS TP 3 to 4 (see Construction Plans and Details).
  - From the top of the east cut bank looking from TP 3 to 2.
  - Panorama from the top of the west side of the east cut of the entire site.
  - Standing on Point 0 looking at TP 9.
  - Standing at the top of the upgradient diversion half culvert looking down the ravine to the west.
  - Culvert entrance to the culvert southerly of TP 9.
  - Outlet of westerly culvert into Queen City Lake.
  - Catch basin near TP 6.
  - Outlet of catch basin near Point 6 into Queen City Lake.
  - Outlet of "upgradient drainage system" into Queen City Lake.
  - Catch basins southwesterly of TP 0.
  - Other specific maintenance items identified.

Original reports will be available within 90 days after the inspection date. The Boeing Company will submit the records of the site inspections to EPA.

If deficiencies are noted during inspections, corrective action will be implemented. A plan and schedule describing the corrective action(s) to be implemented will be submitted to EPA within 90 days after the deficiency was identified. Emergency situations will be immediately brought to the attention of the appropriate persons/agencies.

4.7 POTENTIAL OPERATING PROBLEMS

Potential site conditions that may trigger corrective action include, but are not limited to, the following (these conditions are also summarized in Table 4-3):

- Pooling of water on the surface of the cover system and in the vicinity of drainage discharge points.
- Excessive growth of vegetation.
- Deterioration or vandalism of locks, benchmarks, or signs.
- Clogging of drainage pipes.
- Cracked or leaking drainage pipes.
- Slope instability.
- Erosion or settlement of cover system.
- Damage caused by burrowing animals or seismic activity.

4.8 SAFETY CONSIDERATIONS

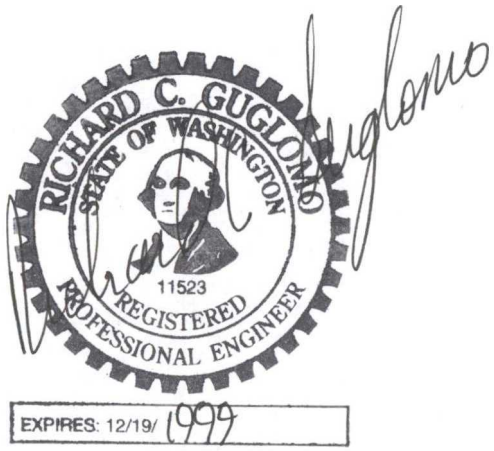
Inspectors will read the current site Health and Safety Plan.

An appropriate confined space entry procedure will be established when entering manholes.

During inspections, special caution will be taken to account for changes in site conditions that might may have occurred between inspections.

5.0 CERTIFICATION

To the best of my knowledge and belief, the Vertical Barrier Wall System Project (Project) at the Queen City Farms, Inc. Superfund site (Site) was completed substantially in accordance with the requirements of the design plans and specifications, including design modifications during construction. The Project was completed using the standard of care as practiced in the State of Washington for construction of this type. To the best of my knowledge and belief, the Vertical Barrier Wall System, including the vertical barrier wall, cover system, and surface water collection system, meets the construction-based performance standards as required by the 8 November 1993 Consent Decree for the Site.



6.0 REFERENCES

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Kennedy/Jenks Consultants. 25 July 1996a. Personal communication (letter to Mr. Steven Tochko, The Boeing Company, regarding modification to the cover system silt specification at the Queen City Farms Superfund site). Mr. Richard C. Guglomo, P.E. and Mr. John E. Norris, Kennedy/Jenks Consultants.

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Kennedy/Jenks Consultants. 4 December 1996. Personal communication (letter to Mr. Steven Tochko, The Boeing Company, regarding modification to the silty sand and gravel specification for the top layer of the cover system at the Queen City Farms Superfund site). Mr. Richard C. Guglomo, P.E. and Mr. John E. Norris, Kennedy/Jenks Consultants.

L.C. Lee & Associates. 7 October 1996. Personal communication (letter to Mr. Fritz Achhorner, Hayward Baker, regarding discharge of bentonite slurry to Queen City Lake). Mr. Mark Cable Rains, L.C. Lee & Associates, Inc.

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Appendix A

As-Built Record Drawings

The As-Built Record Drawings are bound under separate cover.

Appendix B

Design and Specifications Modifications

DESIGN/SPECIFICATION MODIFICATION FORM

RECEIVED
THE BOEING COMPANY

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing **CONTRACTOR:** Hayward Baker, Inc.
LOCATION: Maple Valley, WA

REMEDIATION PROJECT

MODIFICATION NUMBER 1

LOCATION/REFERENCE OF MODIFICATION: Throughout cover system expansion.

MODIFICATION MADE: Change TRD specification Section 02200 by modifying Paragraph 2.03, and adding new Paragraph 3.07. Refer to attached letter dated 25 July 1996.

	NAME	COMPANY	DATE
APPROVED BY DESIGNER:	Edward C. Englund	Kennedy/Jenks	7/26/96
ACKNOWLEDGED BY OWNER:	* Brian A. Culbertson	BOEING	8/6/96
RECEIVED BY CONTRACTOR:	FRITZ N. ACHHORNER	HAYWARD BAKER	7.26.96
ACKNOWLEDGED BY EPA:	Neil Thompson	EPA	8/8/96

REMARKS: * As per attached conditions

ATTACHMENTS: Kennedy/Jenks Consultants' letter to Hayward Baker and Boeing dated 25 July 1996; Hong West & Associates Laboratory Testing Results Report No. 1 dated January 2, 1996.

The Boeing Company acknowledges and approves Design/Specification Modification Number 1 under the following conditions:

1) The cap silt meets the material, placement, and CQC specifications presented in the attached Golder Associates memo dated July 31, 1996 (ref. #963-1360,100) and the proposed construction quality assurance program presented in the Hayward Baker letter dated July 12, 1996 (?) (doc. haywardb/misc/cqc.doc).

2) The cover material currently placed over the soil bentonite backfill from approximately Sta. 17+00 to Sta. 21+35 be removed and placed as fill outside the trench alignment.

3) There is no addional cost to The Boeing Company as a result of these proposed modifications.

8/6/96

HAYWARD BAKER
A Keller Company

BOEING - Queen City Farms Remediation Project
Job Number 53099
22715 SE 168th Way
Maple Valley, WA 98038
Phone (206) 391 - 6607
Fax (206) 391 - 9588

June 12, 1996 **c:\haywardb\misc\cqc.doc**

To: Brian Anderson, Boeing

From: Fritz Achhorner, Hayward Baker, Inc.
John Norris, Kennedy/Jenks Consultants

RE: Construction Quality Control - Silt Layer

This letter presents a proposed construction quality control (CQC) program for the silt layer at the Queen City Farms Superfund Site. This CQC program is based on the requirements presented in the Golder Associates memorandum dated 31 July 1996 ("the memo") and our meeting with you on 31 July 1996.

Hayward Baker proposes to provide silt meeting the material and placement requirements presented in the memo. However, Hayward Baker proposes to use equipment other than the wedge-foot compactor identified in the memo. Golder Associates will evaluate the equipment proposed for compaction.

Hayward Baker, Kennedy/Jenks Consultants, and Hong West and Associates propose to provide full-time CQC as follows:

- Christopher Kovac or another identified Hayward Baker representative will observe placement of the silt material to assess compliance with requirements for lift thickness, absence of deleterious material, presence of oversized particles, and protrusion of items greater than 1/4-inch above the final surface of the silt cover. Kennedy/Jenks Consultants also will provide these services (when not provided by the Hayward Baker representative) during their periodic inspections. In addition, Kennedy/Jenks Consultants will review material testing results as available.

- Hong West and Associates will test materials according to the frequency and test methods described in the memo. However, we propose changing the moisture-density test frequency to once per 500 cubic yard (as described in the earthwork specifications contained in the Task Remedial Design Report) after five tests. This change is based on the assumption that these initial test results will meet the test standard. If the initial test results do not meet the test standard, we will use the test frequency specified in the memo or another frequency that is mutually agreeable.

KELLER

HAYWARD BAKER
A Keller Company

BOEING - Queen City Farms Remediation Project
Job Number 53099
22715 SE 168th Way
Maple Valley, WA 98038
Phone (206) 391 - 6607
Fax (206) 391 - 9588

Hayward Baker and Kennedy/Jenks Consultants are confident this CQC program will provide adequate inspection to ensure that the silt meets the requirements presented in the memo. Please call us if you have any questions.

Sincerely,

Fritz Achhorner
Project Superintendent
Hayward Baker

for John Norris
Vice President
Kennedy/Jenks Consultants

KELLER

MEMORANDUM

TO: B.Anderson (Boeing) July 31, 1996

FR: W.C. Adams (Golder Associates) WCA

RE: DRAFT MATERIAL SPECIFICATIONS FOR SOIL COVER, BOEING QUEEN CITY FARMS Our ref 963-1360.100

We understand that Kennedy-Jenks has proposed an addendum to change the original specifications for the silt cap material on the Boeing, Queen City Farms project. The material proposed for use as the replacement soil cover appears to be adequate for the intended use provided that the following material and placement specifications are met:

Material

- Minimum 85 percent passing the No. 10 sieve
- Minimum 70 percent passing the No. 200 sieve
- No "oversized" particles greater than 3 inches in maximum dimension
- The PI shall be ≥ 4, and moisture reconditioning may be necessary if the PI is greater than 15
- The material shall be free of organics, debris, and other deleterious material

Placement

- Compact to at least 90 percent maximum dry density as determined by ASTM D 698
- Moisture condition to a moisture content greater than the optimum moisture content as determined by ASTM D 698
- Place in loose lifts that are no greater than 8 inches thick and compacted as described above
- Compaction shall be performed using a self-propelled, wedge-foot compactor such as a CAT 815 or equivalent
- The final surface shall be compacted with a smooth-drum roller to produce a smooth finished surface free of irregularities greater than 1/4 inch
- No rocks or other protrusions shall extend greater than 1/4 inch above the final surface of soil cover.

CQC

- The contractor shall provide full-time CQC observation and testing while placement of soil cover material is occurring
- The CQC testing frequency shall be as follows:
    - Moisture-density (ASTM D 2922 (nuclear testing methods)), tested after placement of every lift and 1 per 10,000 ft^2 per lift (minimum)
    - grain-size (ASTM D422) 1/1000 cy
    - Proctor (ASTM ~~D1557~~ 698) 1/1000 cy

Sam

Kennedy/Jenks Consultants

Engineers and Scientists
530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

25 July 1996

Mr. Fritz Achhorner
Hayward Baker
Queen City Farms Project Site
22715 SE 168th Way
Maple Valley, Washington 98038

Mr. Steven Tochko, P.E.
The Boeing Company
Queen City Farms Remediation Project
22715 SE 168th Way
Maple Valley, Washington 98033

Subject: Modification to Cover System Silt Specification
Vertical Barrier Wall System (VBWS) TRD
Queen City Farms, King County, Washington
K/J 966052.02

This letter addresses modifications to Parts 2 and 3 of Specification Section 02200 of the subject TRD. Silt material available from siltation basins at the Stoneway gravel pit, adjacent to the Queen City Farms site, was identified during the VBWS design phase as a potential source of suitable material for the base layer of the cover system expansion. Samples of the "Stoneway silt" material were submitted to Hong West & Associates for laboratory testing during the design phase. The samples were collected directly from a siltation basin. Testing included: moisture content (ASTM D 2216), grain size analysis (ASTM D 422), Atterberg Limits (ASTM D 4318), moisture/density relationship (ASTM D 698), and soil-geosynthetic interaction (ASTM D 5321). The results of these tests (copy attached) compared favorably with the specification for the "Mt. Baker silt" material originally used for the IRM cover system, and the values obtained were incorporated into the design analyses.

Recent grain size analysis of the Stoneway silt removed from the siltation basins and stockpiled indicates that 100 percent of the available material will not pass the #10 sieve, as currently specified. The oversized material is mostly well-rounded gravel and smaller cobbles. The specification modifications presented herein are intended to define conditions that allow for the use of the available Stoneway silt material, without compromising the cover system design.

DISCUSSION

The silt layer serves several important functions in the cover system design: (1) it provides a stable foundation layer for placement of subsequent layers of cover material, (2) it provides a relatively "smooth" (or defect-free) surface for contact with the PVC geomembrane, and (3) it provides a relatively low-permeability buffer material beneath the PVC geomembrane. As long as the percentage of coarser material in the Stoneway silt remains low enough that any gravel or cobbles are matrix supported (suspended in a matrix predominated by fines), the material properties governing functions (1) and (3) above will remain essentially the same as those determined during design phase testing, and used in the design analyses. Ensuring that function (3) is maintained will require that no materials that could puncture, abrade, or otherwise damage the integrity of the geomembrane (i.e., "deleterious material"), be permitted to remain on the surface of the final silt lift.

SPECIFICATION MODIFICATIONS

Modify Paragraph 2.03 of Section 02200 to read:

"2.03 SILT

A. Silt used for the silt layer under the PVC geomembrane and for fines within the Soil Bentonite (SB) slurry wall backfill material shall meet the following gradation:

Sieve Size	Percentage Passing (by weight)
#10	85
#200	70

Oversized material shall be limited to 6 inches in maximum dimension.

Perform grain size distribution test (ASTM D 422) for each 1,000 cubic yards of material used for cover construction. The plasticity index of the silt used in the final cap shall be no less than 4. The silt shall be free of organics, debris, or other deleterious material."

Add Paragraph 3.07 to Section 02200:

"3.07 PLACEMENT OF SILT COVER

A. Following placement of the final lift of cover silt, visually inspect the silt surface over which the PVC geomembrane will be installed to ensure that it is free of materials that may damage the PVC geomembrane. Remove all gravel and cobbles that are protruding or have large exposed surfaces. Remove any exposed gravel or cobble having angular or subangular surfaces. Fill cavities/disturbed areas created at locations where gravel and cobbles are removed with silt material that is free of gravel and cobbles. Compact silt layer to a minimum of 90 percent of the maximum dry density as determined by ASTM D 698, and test in accordance with Paragraph 3.04 of this section."

These modified specifications are consistent with the intent of the extended cover system silt layer design presented in the 100 percent VBWS TRD submittal. Please contact us at (206) 874-0555 if you have any questions or require additional information.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Richard C. Guglomo, P.E.
Chief Engineer

John E. Norris
Vice President

RCG/JEN:nd
7rcg1L.doc

RICHARD C. GUGLOMO
STATE OF WASHINGTON
11523
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES: 12/19/97

HONG WEST
& ASSOCIATES, INC.

Geotechnical Engineering
Hydrogeology
Geoenvironmental Services
Testing & Inspection

LABORATORY TESTING RESULT SUMMARY

QUEEN CITY FARMS PROJECT
HWA Project No.: 95163
Report No.1
January 2, 1996

RECEIVED
JAN 4 - 1996
K/J Federal Way
K/J No/File 256052.01
Route
Return To/By

Prepared for

Kennedy-Jenks Consultants, Inc.
5190 Neil Road, Suite 300
Reno, Nevada 89502

Attention: Mr. Eric Rehwold, PE

In accordance with your request, Hong West & Associates, Inc., has undertaken and completed a testing program outlined by Mr. Eric Rehwold of Kennedy-Jenks Consultants, Inc., on the specified soil samples submitted for testing during the Queen City Farms Cover Project. Herein, we present the results of our laboratory analyses. The samples were submitted by Mr. John Norris from the Federal Way Washington office of Kennedy-Jenks Consultants, Inc. The testing was conducted in accordance with the clients request and the following specifications. The soil/geosynthetic shear testing was conducted by HWA's subcontractor GeoSyntec Consultants of Atlanta, Georgia. The test results are summarized on the accompanying data tables and data curves.

Moisture Content: The moisture content of the submitted soil sample was determined in general accordance with **ASTM D 2216.**

Grain Size Analysis: The grainsize distribution for the submitted soil sample was determined in general accordance with **ASTM D 422** (wash sieve method). The results are presented on the attached grain size distribution curve.

Atterberg Limits: The liquid limit, plastic limit and plasticity index of the submitted soil sample was determined in general accordance with **ASTM D 4318.** The data is summarized in Table 1.

Moisture/Density Relationship: The moisture/density relationships were determined for the specified soil sample in general accordance with **ASTM D 698.** The data is summarized in Table 1 and presented on the attached data curve.

19730-64th Avenue West
Lynnwood, WA 98036-5904
Tel. 206-774-0106
Fax 206-775-7506

January 2, 1996
HWA Project No. 95163

Soil-Geosynthetic Interaction Testing:: The shear resistance of geosynthetic against soil was determined in general accordance with ASTM D 5321 by HWA subcontractor GeoSyntec Consultants, Inc. As requested by the client, testing was conducted between the submitted lean clay soil and 30 mil. PVC geomembrane samples. The clay was compacted at optimum moisture content to 90% of its' laboratory maximum dry density per ASTM D 698. After positioning the geomembrane on the compacted soil the samples were soaked and consolidated under the appropriate normal load (either 250, 500, 1000 and 2000 psf). To approximate "drained" conditions the shear rate was estimated using consolidation data and procedures outlined in ASTM D 3080(Note 9). The testing procedure is more fully described in the accompanying report produced by GeoSyntec Consultants, Inc. which is attached.

This testing program was conducted in general accordance with the above mentioned procedures. These tests were conducted for the exclusive use and interpretation of the client and their engineers utilizing the generally accepted laboratory procedures. Experience has shown that test values derived by these standard methods vary with each representative sample. HWA has no knowledge with regard to the extent and quantities of materials these samples represent. HWA has no specific knowledge with regard to the field sampling procedures, the lateral variability of geologic materials on site or the possible quantities of material these samples represent. No warranty, expressed or implied is made.

Thank you for this opportunity to serve you. Should you have any questions regarding these results please do not hesitate to inquire.

Respectfully Submitted,

HONG WEST & ASSOCIATES, INC.

Steven E. Greene
Soil Laboratory Manager

cc: Mr. John Norris Kennedy-Jenks/Federal Way, Washington

HONGWEST & ASSOCIATES, INC.

Queen City Farms Cover Project
HWA Project No. 95163, Report No. 1
January 2, 1996
Laboratory Testing Summary
TABLE 1

Sample Designation	Soil Classification ASTM D 2487	Atterberg Limits ASTM D 4318	Moisture-Density Relationship ASTM D 698	Soil-Geosynthetic Shear[1] ASTM D 5321
S-1	CL	LL = 35.7% PL = 22.8% PI = 12.9% As Received Moisture = 35.0%	Laboratory Maximum Dry Density = 111.8 pcf @ 17.1% Moisture.	phi = 28° a = 53 psf

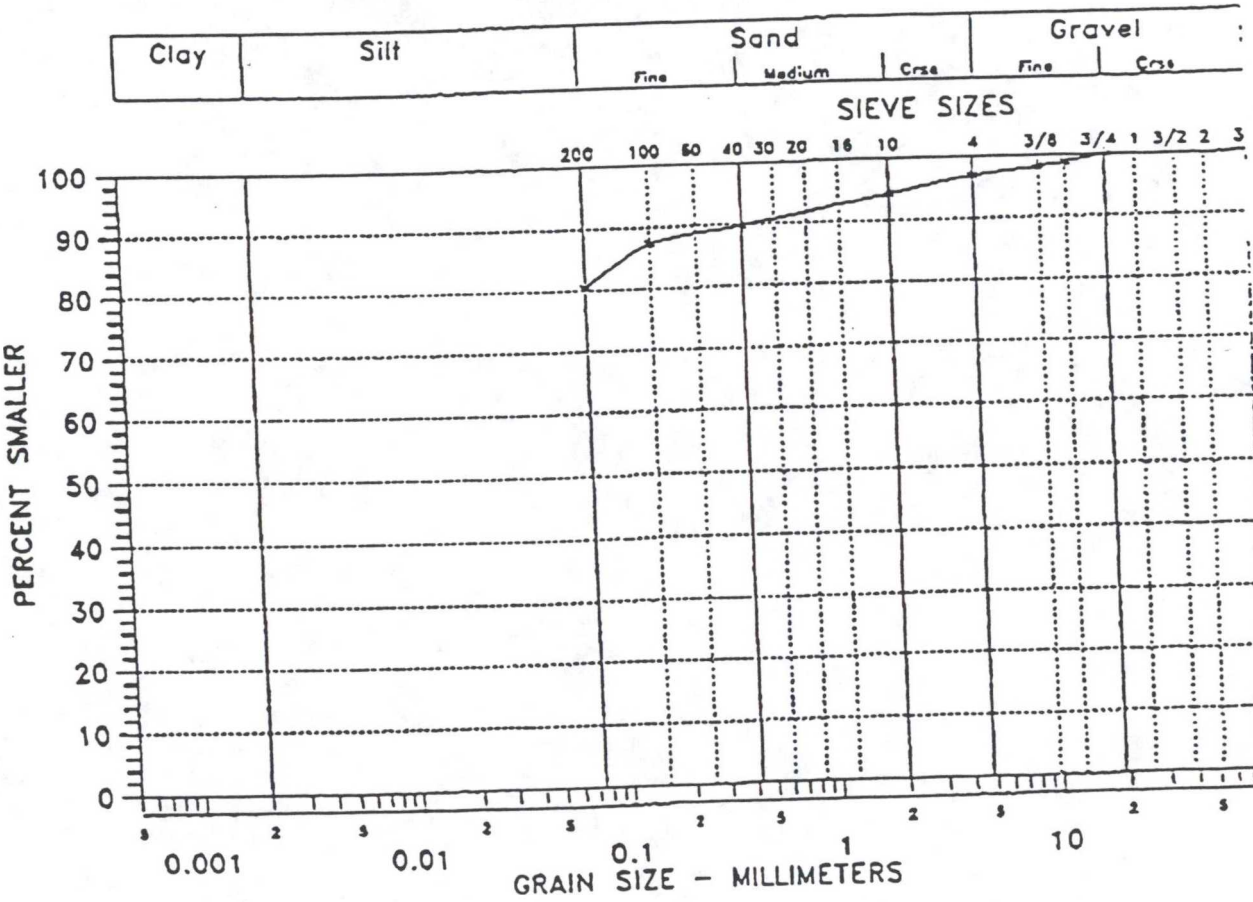
1. See attached report from GeoSyntec Consultants, Inc., for additional information.

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION

Project: Queen City Farms
Location: King County, Washington
Project Number: 95163
Date Tested: 11/17/95
Remarks: Olive brown, Lean CLAY with sand (CL)
Atterberg Limits: LL= 35.7 percent
PL= 22.8 percent
PI= 12.9 percent

Proposed Use: Cover soil
Sample Number: S-1

Sample Description:
Gravel: 3.1
Sand: 16.5
Fines: 80.4



HONG WEST & ASSOCIATES

• Geotechnical Engineering • Hydrogeology • Materials Testing • Construction Inspection •

COMPACTION TEST RESULTS

Project: Queen City Farms
Address: King County, Washington

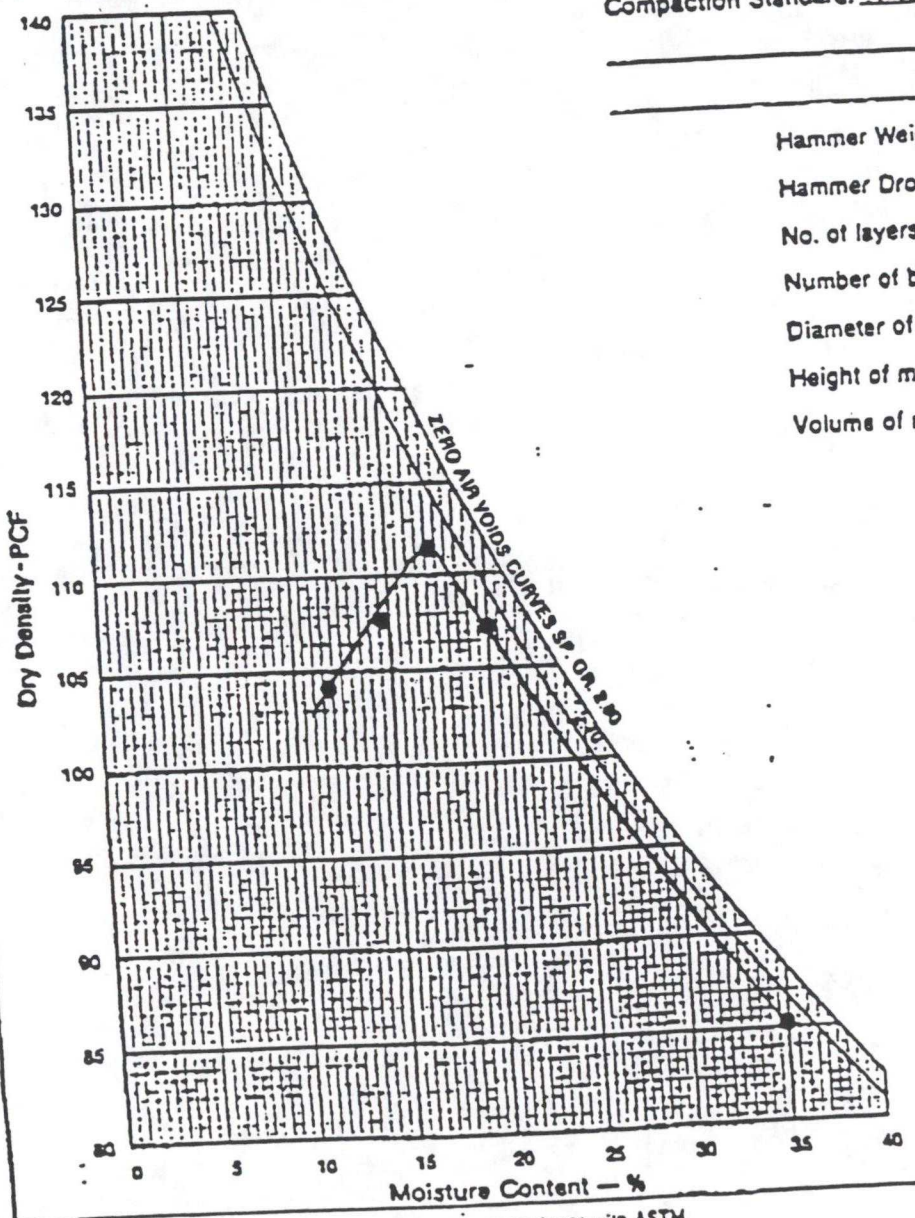
Job Number: 95163
Date Tested: 11/16/95 By: WF
Client: Kennedy-Jenks

Attention: Mr. John Norris

Sample Number: S-1 TRS No.:
Sample Location: Engineering Submittal
Sample Description: Olive brown, lean clay with sand (CL)

Maximum Dry Density: 111.8 PCF
Optimum Moisture Content: 17.1 %
Natural Moisture Content: 35.0 %
Compaction Standard: ASTM D 698

Hammer Weight: 5 lbs.
Hammer Drop: 12 ins.
No. of layers: 3
Number of blows/layer: 25
Diameter of mold: 4 ins.
Height of mold: 4.584 ins.
Volume of mold: 1/30 cu. ft.



All tests performed in accordance with ASTM

Interface Direct Shear Testing

Prepared for

HONG WEST & ASSOCIATES, INC.

By

GeoSyntec Consultants
5775 Peachtree Dunwoody Road, Suite 11D
Atlanta, Georgia 30342

GEOSYNTEC CONSULTANTS

Soil-Geosynthetic Interaction
Testing Laboratory
5775 Peachtree Dunwoody Road, Suite 11D
Atlanta, Georgia 30342 • USA
Tel. (404) 705-9500 • Fax (404) 705-9300

21 December 1995

Mr. Steven E. Greene
Manager, Laboratory and Field Services
Hong West & Associates, Inc.
19730-64th Avenue West
Lynnwood, Washington 98036-5904

Subject: Final Report
Interface Direct Shear Testing
Queen City Farms Project
Hong West Project No. 95163

Dear Mr. Greene:

GeoSyntec Consultants (GeoSyntec) is pleased to present the enclosed final report on the interface direct shear testing performed for Hong West & Associates, Inc. (Hong West) for the Queen City Farms project, Hong West Project No. 95163. The testing program was conducted in accordance with the test procedures defined in the 17 November 1995 letter prepared by Mr. Steven E. Greene of Hong West and transmitted to Mr. Robert H. Swan, Jr. of GeoSyntec. All of the testing was conducted at GeoSyntec's Soil-Geosynthetic Interaction Testing Laboratory located in Atlanta, Georgia.

GeoSyntec appreciates the opportunity to provide laboratory testing services to Hong West for the Queen City Farms project. Should you have any questions regarding the enclosed report, please do not hesitate to contact any of the undersigned.

Sincerely,

Zehong Yuan, Ph.D., P.E.
Assistant Program Manager

Robert H. Swan, Jr.
Laboratory Manager

Gary R. Schmertmann, Ph.D., P.E. (Georgia)
Senior Project Engineer

Enclosure

GLI3962/SGI95385

Corporate Office:
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Atlanta, GA • Austin, TX • Boca Raton, FL • Chicago, IL • Columbia, MD
Huntington Beach, CA • San Antonio, TX • Walnut Creek, CA
Brussels, Belgium • Nancy, France

Laboratories:
Atlanta, GA
Boca Raton, FL
Huntington Beach, CA

RECYCLED AND RECYCLABLE

Prepared for

Hong West & Associates, Inc.
19730-64th Avenue West
Lynnwood, Washington 98036-5904

FINAL REPORT
INTERFACE DIRECT SHEAR TESTING

QUEEN CITY FARMS PROJECT
HONG WEST PROJECT NO. 95163

Prepared by

GeoSyntec Consultants
Soil-Geosynthetic Interaction Testing Laboratory
5775 Peachtree Dunwoody Road, Suite 11D
Atlanta, Georgia 30342

Project Number GLI3962

21 December 1995

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1. INTRODUCTION

This report was prepared by Mr. Robert H. Swan, Jr. and Dr. Zehong Yuan, P.E. (Georgia), both of GeoSyntec Consultants (GeoSyntec), Atlanta, Georgia. The report was reviewed by Dr. Gary R. Schmermann. P.E. (Georgia), also of GeoSyntec, in accordance with the internal peer review policy of the firm. The laboratory testing program described in this report was performed at the request and authorization of Mr. Steven E. Greene of Hong West & Associates, Inc. (Hong West), Lynnwood, Washington.

Hong West authorized GeoSyntec to undertake a laboratory testing program to evaluate the shearing resistance of the interface between a site soil and a geomembrane for the Queen City Farms project, Hong West Project No. 95163. GeoSyntec understands that the sample preparation procedures and testing conditions used in the testing program were selected by Mr. Greene of Hong West to model anticipated field conditions. All of the laboratory testing was conducted at GeoSyntec's Soil-Geosynthetic Interaction Testing Laboratory located in Atlanta, Georgia.

2. TESTING PROGRAM

2.1 Scope

The testing program consisted of an interface direct shear test series. The interface direct shear test series consisted of four tests.

2.2 Testing Methods

The interface direct shear tests were performed in general accordance with the American Society for Testing and Materials (ASTM) Standard Test Method D 5321, "*Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method*". The tests were conducted in a large direct shear device containing an upper and lower shear box. The upper shear box measures 12 in. by 12 in. (300 mm by 300 mm) in plan and 3 in. (75 mm) in depth. The lower shear box measures 12 in. by 14 in. (300 mm by 350 mm) in plan and 3 in. (75 mm) in depth.

2.3 Geosynthetic and Soil Materials

The geosynthetic and soil materials used in the testing program are presented in Appendix A. All of the test materials were provided to GeoSyntec by Hong West. A concrete sand was provided by GeoSyntec to fill the lower shear box and serve as a bedding layer below each test interface in the interface direct shear tests.

2.4 Test Configuration and Procedures

The configuration of the test specimens and the specific test procedures used to conduct each of the interface direct shear tests are presented in Appendix B. GeoSyntec understands that the test procedures and test conditions were selected by Hong West to model anticipated field conditions.

3. TEST RESULTS

The total-stress shearing resistance was evaluated for each applied normal stress. The test data were plotted on a graph of shear force versus horizontal displacement. The resulting plots are presented in Appendix C. The peak value of shear force was used to calculate the peak shear strength. For this report, the residual shear strength was calculated using the stabilized post-peak shear force measured at the end of each test. No area correction was used when computing normal and shear stresses because each test was performed using a constant effective sample area (i.e., the area of the geomembrane specimen was larger than that of the upper shear box).

The calculated shear strengths were plotted on a graph of shear stress versus normal stress and the results were used to evaluate total-stress peak and residual strength envelopes. A best-fit straight line was drawn through the data points from the test series to obtain total-stress peak and residual friction angles and adhesions. The coefficient of correlation (R^2), a standard statistical indicator of how well the best-fit line matches the test data, was obtained for each best-fit line. The summary plots of shear stress versus normal stress for the test series are also presented in Appendix C. The friction angles, adhesions, and R^2 values derived from the plotted test results are presented in Table 1.

For the test series, it is noted that the reported adhesion is the shear stress axis intercept of the best fit straight line drawn through the test data on a plot of shear stress versus normal stress. This value may not be the true adhesion of the interface and caution should be exercised in using this adhesion value for applications involving normal stresses outside the range of stresses covered by the test series.

4. CLOSURE

The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analyses unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. This testing report is submitted for the exclusive use of Hong West.

TABLE 1

INTERFACE DIRECT SHEAR TEST RESULTS
MEASURED TOTAL STRESS SHEAR STRENGTH PARAMETERS
HONG WEST & ASSOCIATES, INC.
QUEEN CITY FARMS PROJECT

Test Series Number	Interfaces Tested[1]	Normal Stress (psf)	Peak Strength[2]			Residual Strength[2]			Reference Appendix Figure Numbers
			Friction Angle	Adhesion (psf)	R^2	Friction Angle	Adhesion (psf)	R^2	
1	Barrier Soil/30-mil PVC Geomembrane With File Finish Against Soil Under Soaked and Slow Shear Conditions	250 to 2,000	28°	53	1.000	28°	53	1.000	C-1, C-2, and C-3

Notes: (1) See Appendix B for detailed test conditions and procedures.

(2) The reported value of adhesion for the test series may not be the true adhesion of the interface and caution should be exercised in using this adhesion value for applications involving normal stresses outside the range of stresses covered by the test series. The value of R^2, the coefficient of correlation, provides an indication of how well the best-fit shear strength parameters match the test data.

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APPENDIX A

GEOSYNTHETIC AND SOIL MATERIALS

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Geosynthetic Materials

A 30-mil (0.75-mm) thick polyvinyl chloride (PVC) geomembrane (manufacturer not specified), referred to as 30-mil PVC geomembrane, was used in the testing program. The geomembrane had a smooth surface on one side of the geomembrane and a file finish surface on the other side of the geomembrane. A bulk sample of the PVC geomembrane was provided to GeoSyntec by Hong West.

Soil Materials

A barrier soil was used in the testing program. A bulk sample of the barrier soil was provided to GeoSyntec by Hong West. The compaction characteristics and placement conditions for the barrier soil were also provided to GeoSyntec by Hong West. A concrete sand was provided by GeoSyntec to fill the lower shear box and serve as a bedding layer below each test interface in the interface direct shear tests.

APPENDIX B

TEST PROCEDURES AND TEST CONDITIONS

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TEST PROCEDURES AND CONDITIONS
TEST SERIES NUMBER: 1

Test Specimen Configuration (from top to bottom) and Placement Conditions:

- upper shear box: barrier soil initially placed at a dry unit weight of 100.1 to 100.7 pcf and a moisture content of 16.8 to 17.2%. Final moisture content ranged from 23.6 to 27.5% for the test series;
- 30-mil PVC geomembrane with file finish against upper soil; and
- lower shear box: bedding layer of compacted concrete sand.

Test Interface: upper soil against geomembrane

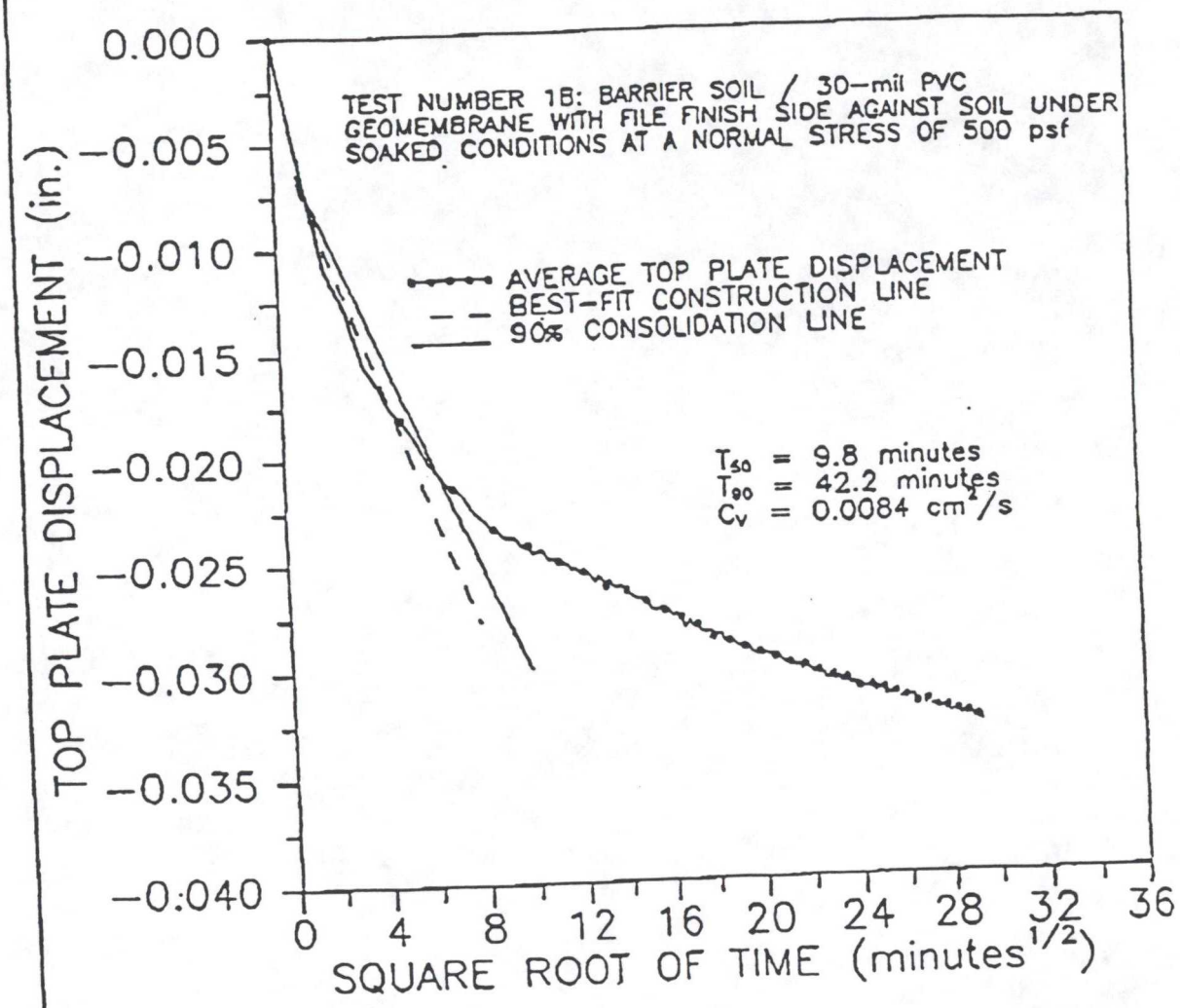
Test Procedures for Each Normal Stress Condition:

- A fresh specimen of concrete sand was compacted into the lower shear box by hand tamping to a relatively dense state under dry conditions forming a 3 in. thick bedding layer.
- A fresh specimen of geomembrane was trimmed from the bulk sample and attached to the lower shear box with mechanical compression clamps. The geomembrane was oriented so that the file finish side was in contact with the upper soil.
- A fresh specimen of the upper soil was compacted away from the geomembrane and then placed on top of the geomembrane specimen for testing. The initial target compaction conditions (i.e., dry unit weight and moisture content) corresponded to 90 percent of the maximum dry unit weight and optimum moisture content based on the results of standard Proctor compaction tests performed by Hong West.
- Soaking conditions: the entire test specimen was soaked for 12 hours under each test normal stress prior to being sheared. The soaking normal stress was applied prior to immersion. For the test conducted at a normal stress of 500 psf, top plate displacements were measured during the soaking phase with the use of two liner variable differential transformers (LVDTs). The average vertical displacements were plotted on a graph of top plate displacement versus square root of time in order to evaluate the time corresponding to 50 percent of consolidation (t_{50}). A constant shear displacement rate was then calculated, by Hong West, assuming that shear failure would occur at a displacement of 2 in., so that the time to failure would approximately equal 50 times t_{50}.
- Test normal stresses: 250, 500, 1,000, or 2,000 psf.
- Shearing of the test specimen followed immediately without any disruption of the test normal stress.
- Constant displacement rate: 0.004 in/min.
- The direction of shear for each interface direct shear test was in the direction of manufacture (machine direction) of the PVC geomembrane sample.
- Each test was sheared until a constant, residual shear load was recorded.

APPENDIX C

TEST RESULTS

HONG WEST & ASSOCIATES, INC.
INTERFACE DIRECT SHEAR TESTING



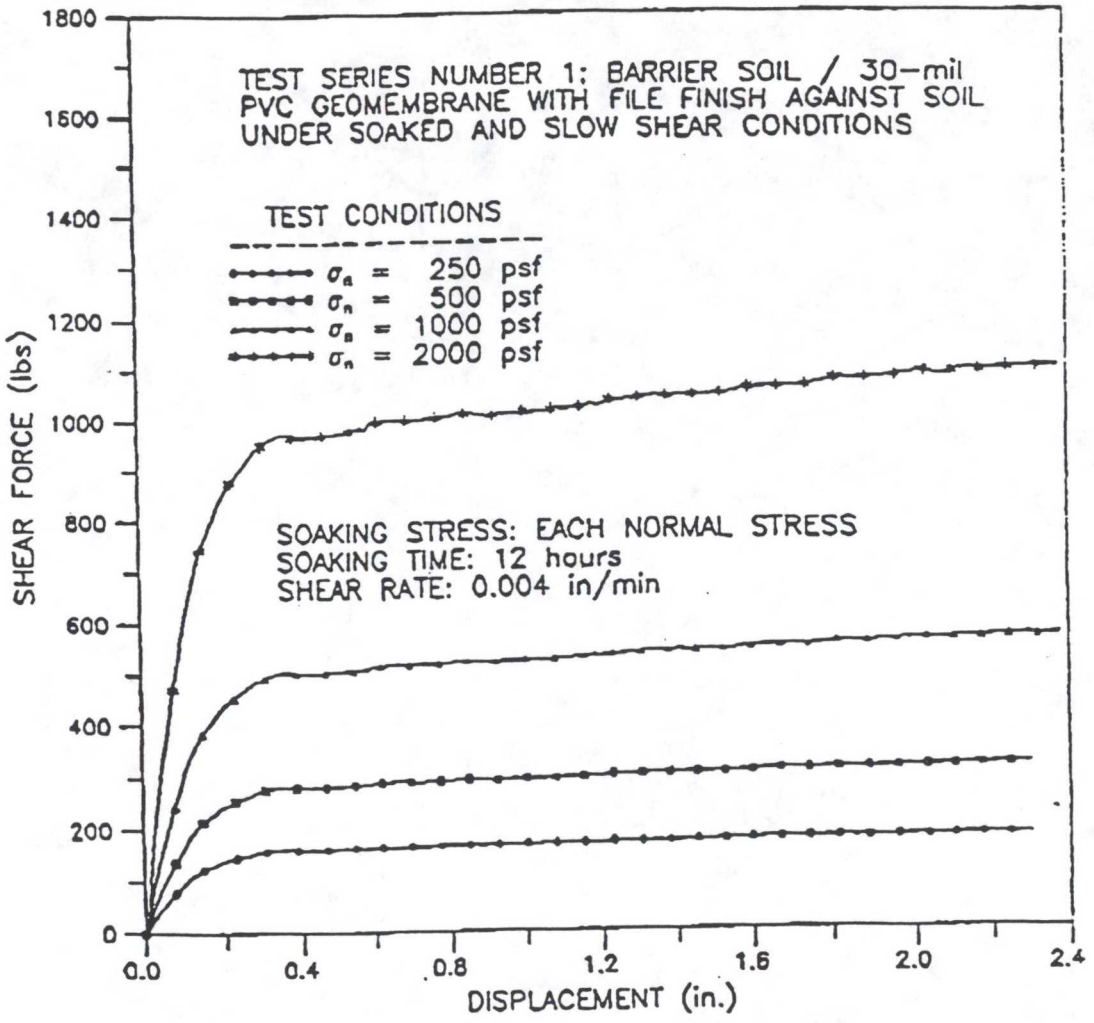
DATE TESTED: 28 TO 29 NOVEMBER 1995

GeoSyntec Consultants

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-1
PROJECT NO.	GL13962
DOCUMENT NO.	SGI95385
FILE NO.	

HONG WEST & ASSOCIATES, INC.
INTERFACE DIRECT SHEAR TESTING



NOTE: The shear box size was 12 in. by 12 in.(300 mm by 300 mm). and the contact area remained constant throughout the entire test.

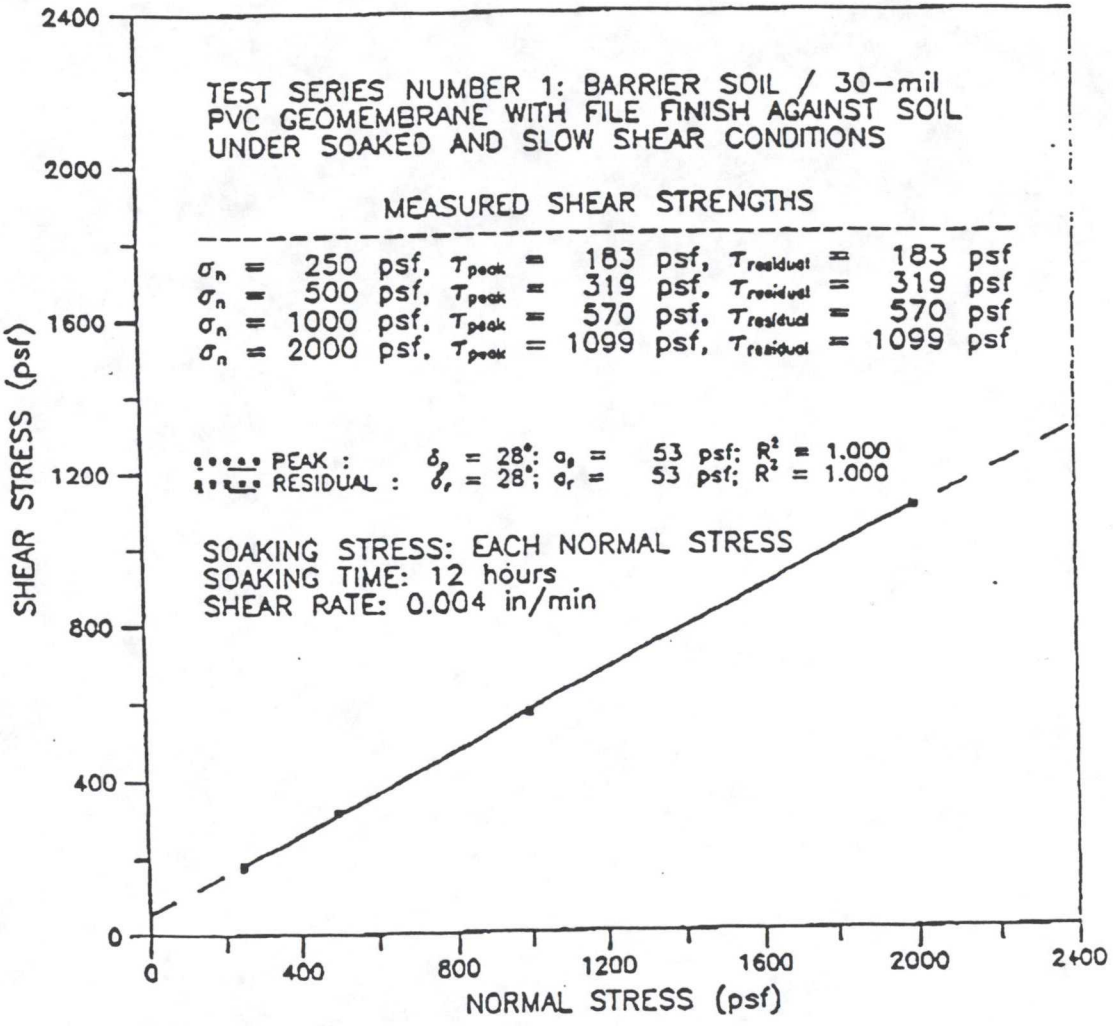
DATE TESTED: 28 NOVEMBER TO 5 DECEMBER 1995

GeoSyntec Consultants

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-2
PROJECT NO.	GL13962
DOCUMENT NO.	SG195325
FILE NO.	

HONG WEST & ASSOCIATES, INC.
INTERFACE DIRECT SHEAR TESTING



NOTE: The reported value of adhesion may not be the true adhesion of the interface, and caution should be exercised in using this adhesion value for applications involving normal stresses outside the range of stresses covered by the test.

DATE TESTED: 28 NOVEMBER TO 5 DECEMBER 1995

GeoSyntec Consultants

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-3
PROJECT NO.	GL13962
DOCUMENT NO.	SG195385
FILE NO.	

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing CONTRACTOR: Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 2

LOCATION/REFERENCE OF MODIFICATION: Throughout cover system expansion

MODIFICATION MADE: Change TRD Specification Section 02200 by modifying Paragraph 2.04. Refer to attached letter dated 26 July 1996.

RECEIVED
JUL 29 1996
GEOTECHNICAL
HAYWARD BAKER INC.

APPROVED BY DESIGNER: Richard C. Inglesmo Kennedy/Jenks 7/26/96
NAME COMPANY DATE

ACKNOWLEDGED BY OWNER: Dan Schuh BOEING 8/1/96
NAME COMPANY DATE

RECEIVED BY CONTRACTOR: FRITZ ACHHORNER Hayward Baker 7/26/96
NAME COMPANY DATE

ACKNOWLEDGED BY EPA: Neil Thompson EPA 8/8/96
NAME COMPANY DATE

REMARKS:

ATTACHMENTS: Kennedy/Jenks Consultants' letter to Hayward Baker and Boeing dated 26 July 1996.

Kennedy/Jenks Consultants

Engineers and Scientists

530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

26 July 1996

Mr. Fritz Achhorner
Hayward Baker
Queen City Farms Project Site
22715 SE 168th Way
Maple Valley, Washington 98038

Mr. Steven Tochko, P.E.
The Boeing Company
Queen City Farms Remediation Project
22715 SE 168th Way
Maple Valley, Washington 98033

Subject: Modification to Sand Specification
Vertical Barrier Wall System (VBWS) TRD
Queen City Farms, King County, Washington
K/J 966052.02

This letter addresses modifications to Part 2 of Specification Section 02200 of the subject TRD. A well-graded sand that is available from the Stoneway gravel pit operation has been identified by Hayward Baker as a potentially suitable material for the cover system expansion drainage layer construction. A sample of the Stoneway sand was recently submitted to Hong West & Associates for laboratory grain size distribution analysis using ASTM D 422. The results of this testing (copy attached) show that the percentages of particles retained on the #10 and 1/4" sieves exceed those established in Specification Section 02200, Paragraph 2.04, which references WSDOT 9-03.13(1). The maximum particle size in the Stoneway sand sample tested was 3/8" minus.

DISCUSSION

The sand that will be placed over the 30-mil PVC geomembrane will serve as a stable, protective layer for the geomembrane, and as a drainage blanket. The material used has to be placed and densified to a firm condition using equipment traffic (or other available means) without damaging the geomembrane. Once densified, the material properties must meet or exceed those used in the cover system design analyses.

The Stoneway material sample tested by Hong West & Associates is a well graded sand (uniformity coefficient, $C_u = 7.1$; curvature coefficient, $C_c = 1.8$). While the Stoneway material contains a higher percentage (~63.5%) of material retained on the #10 sieve than that specified by WSDOT 9-03.13(1), the hydraulic conductivity and strength of the Stoneway material, once placed and rolled, can meet the functional requirements of the cover system design.

SPECIFICATION MODIFICATION

Modify Paragraph 2.04 of Section 02200 to read:

"2.04 SAND

A. The sand shall consist of granular material, free from wood, bark, or other extraneous material and shall meet the following requirements for grading:

Sieve Size	Percentage Passing (by weight)
2 1/2" square	100
1/4" square	90-100

The portion passing 1/4" shall meet the following requirements for grading:

U.S. No. 10	30-100
U.S. No. 50	0-30
U.S. No. 100	0-7.0
U.S. No. 200	0-3.0

Sand shall have a uniformity coefficient, C_u, of 6 or greater. That portion of the sand material retained on a 1/ 4-inch square sieve shall contain not more than 0.05 percent by weight of wood waste."

These modified specifications are consistent with the intent of the extended cover system sand layer design presented in the 100 percent VBWS TRD submittal. Please contact us at (206) 874-0555 if you have any questions or require additional information.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Richard C. Guglomo, P.E.
Chief Engineer

John E. Norris
Vice President

RICHARD C. GUGLOMO
STATE OF WASHINGTON
11523
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES: 12/19/97

RCG/JEN:ll
7rcg2L.doc

HONG WEST & ASSOCIATES, INC.

HWA MATERIALS TESTING LABORATORY
Particle-Size Analysis Of Soils (ASTM D 422)

Project: Queen City Farms
Location: Cedar Grove, Washington
HWA Project No.: 96072-400
Date Tested: 7/22/96 **By:** WF
Client: Hayward-Baker

TRS No.: 412 **Sample No.:** S-18
Sample Description: Very dark grayish brown, well graded SAND with gravel (SW) (STONEWAY SAND)
Sample Location: On site
Maximum Particle Size: 3/8" minus

	SIEVE ANALYSIS		TEST DATA	SPECIFICATION LIMITS
Sieve Size	Weight Retained	Weight Passing	Percent Passing	
2 1/2"				
2"				
1 1/2"				
1 1/4"				
1"				
3/4"				
5/8"				
1/2"				
3/8"			100 %	
1/4"			98.9%	
No. 4			84.2%	
No. 8				
No. 10			36.5%	
No. 16				
No. 20			18.0%	
No. 30				
No. 40			10.1%	
No. 50				
No. 60			6.9%	
No. 80				
No. 100			4.0%	
No. 200			1.2%	
Pan				
Wash				

Reviewed By: _____

Page ____ of ____.

This report applies only to the item(s) tested, and may be reproduced in full, with written approval of HWA.

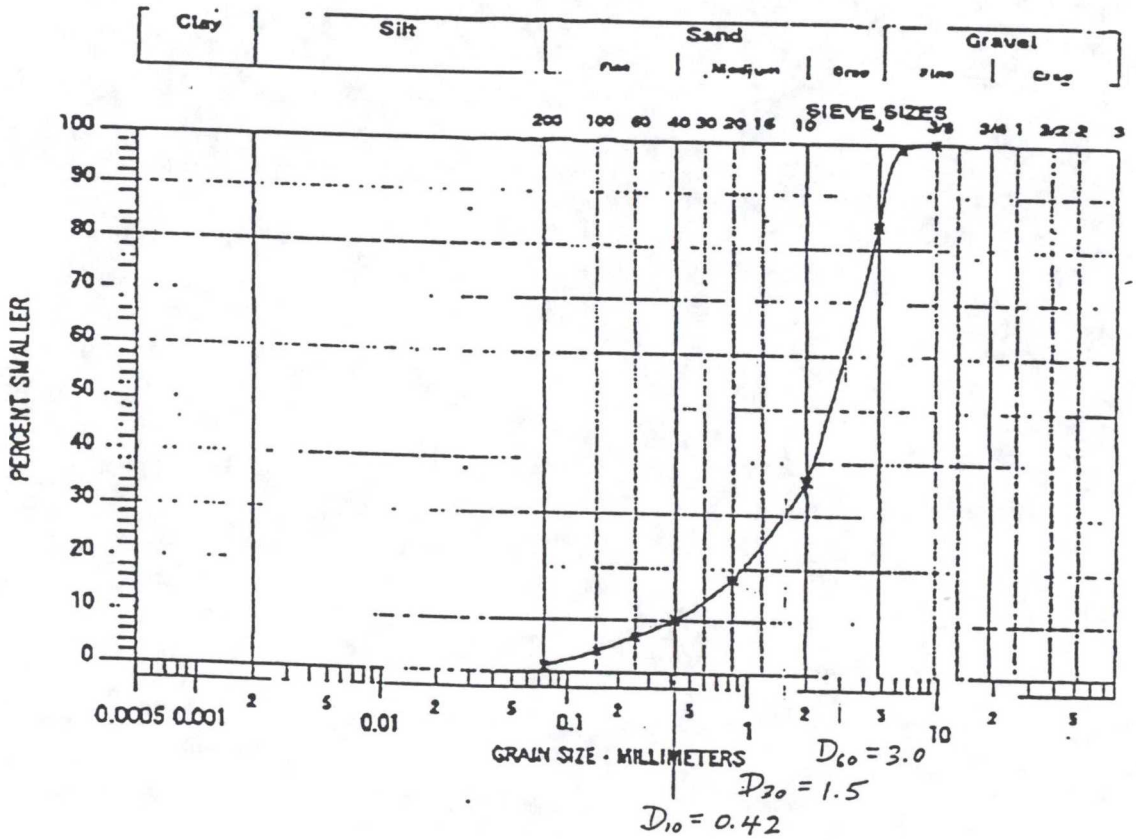
Revised 2/94

STONEWAY SAND

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION
ASTM D422

Project: Queen City Farms
Location: Cedar Grove, WA
Project Number: 96072-400
Date Tested: 7/22/96
Remarks: Very dark grayish brown, well graded SAND with gravel (SW)

Test Hole Number:
Sample Number: S-18
Depth:
Sample Description:
Gravel: 15.8
Sand: 83.0
Fines: 1.2



$D_{60} = 3.0$
$D_{30} = 1.5$
$D_{10} = 0.42$

Reviewed by: James P. Hong

$$C_u = \frac{D_{60}}{D_{10}} = \frac{3.0}{0.42} = 7.1$$

$$C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(1.5)^2}{(0.42)(3.0)} = 1.8$$

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing CONTRACTOR: Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 3

LOCATION/REFERENCE OF MODIFICATION: New cover system within northeast/east portion of the barrier wall from approximately Sta. 17 + 00 to 21 + 35.

MODIFICATION MADE: (1) Change TRD Specification Section 02918 by modifying Line C of Paragraph 2.01. (2) Conditionally approve use of alternate PVC geomembrane product for northeast/east portion of new cover. Refer to attached letter dated 23 August 1996.

APPROVED BY DESIGNER: Richard C. Inglomo KJ 8/23/96
NAME COMPANY DATE

ACKNOWLEDGED BY OWNER: _____
NAME COMPANY DATE

RECEIVED BY CONTRACTOR: _____
NAME COMPANY DATE

ACKNOWLEDGED BY EPA: _____
NAME COMPANY DATE

REMARKS: _____

ATTACHMENTS: Kennedy/Jenks Consultants' letter to Hayward Baker and Boeing dated 23 August 1996.

Kennedy/Jenks Consultants

Engineers and Scientists

530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8686 (Tacoma)
FAX 206-952-3435

23 August 1996

Mr. Fritz Achhorner
Hayward Baker
Queen City Farms Project Site
22715 SE 168th Way
Maple Valley, Washington 98038

Mr. Steven Tochko, P.E.
The Boeing Company
Queen City Farms Remediation Project
22715 SE 168th Way
Maple Valley, Washington 98033

Subject: Modification to Cover System PVC Geomembrane Specification
Vertical Barrier Wall System (VBWS) TRD
Queen City Farms, King County, Washington
K/J 966052.02

This letter addresses (1) modifications to Line C of Subpart 2.01 of Specification Section 02918 of the subject TRD, and (2) the use of PVC geomembrane material already delivered by Layfield Plastics to the Queen City Farm project site. The words "chevron pattern" are used in the referenced specification line to describe the surface texture of one side of the PVC material originally furnished by Layfield Plastics for interface shear strength testing during the VBWS design phase. Based on discussions with Layfield Plastics, the terminology "file finish" better describes the surface of the specific PVC material tested. It is this file finish that is key to the development of the geosynthetic/soil interface shear strength exhibited during the design phase testing.

PVC geomembrane delivered to the site for the initial phase of cover system construction was calendered using a different press than that used to produce the geomembrane originally tested, and has a "taffeta finish" that is different from the file finish of the original material. The onsite PVC geomembrane material will be used in construction of the new cover (within northeast/east portion of the barrier wall) from approximately Sta. 17 + 00 to 21 + 35. The slopes upon which geomembrane will be placed in this new cover area are 7:1 (H:V) or flatter. Revised analysis of the slope stability for this portion of the cover, assuming a 15° interface friction angle and 50 psf interface adhesion, indicates that the new slope should be stable under static loading conditions and exhibit satisfactory resistance to permanent deformation under design earthquake loading. We consider the interface friction angle and adhesion values used in the revised slope stability analysis to be reasonable based on the characteristics of

the silt and taffeta finish PVC geomembrane material. The portion of the existing cover system constructed using smooth PVC geomembrane to a 5:1 (H:V) slope with an approximate 30-foot slope height provides empirical evidence of the stability of the cover system with smooth PVC at a slope that is substantially steeper than 7:1 (H:V). Accordingly, we consider the use of the taffeta finish PVC membrane material presently onsite to construct the northeast/east portion of the new cover to be consistent with the intent of the design presented in the 100% VBWS TRD submittal.

SPECIFICATION MODIFICATIONS

Modify Line C of Paragraph 2.01 of Section 02918 to read:

> "C. Provide material with a file finish embossed into the surface of one side. Engineer to provide sample of acceptable material. If alternate material is proposed, provide Engineer with alternate material for evaluation."

Please contact us at (206) 874-0555 if you have any questions or require additional information.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Richard C. Guglomo

Richard C. Guglomo, P.E.
Chief Engineer

John E. Norris
Vice President

RCG/JEN:ll
8rcg1L

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing CONTRACTOR: Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 4

LOCATION/REFERENCE OF MODIFICATION: Throughout cover system expansion.

MODIFICATION MADE: Change TRD Specification Section 02918 by modifying Line B of Paragraph 2.01. Refer to attached letter dated 10 September 1996

	NAME	COMPANY	DATE
APPROVED BY DESIGNER:	Richard C. Scaglione	KJC	9/10/96
ACKNOWLEDGED BY OWNER:	[signature]	BOEING	9/11/96
RECEIVED BY CONTRACTOR:	Fritz Achhorner	Hayward Baker	9/10/96
ACKNOWLEDGED BY EPA:	Neil E. Thompson	EPA	9/17/96

REMARKS:

ATTACHMENTS: Kennedy/Jenks Consultants' letter to Hayward Baker and Boeing dated 10 September 1996.

Kennedy/Jenks Consultants

Engineers and Scientists

530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

10 September 1996

Mr. Fritz Achhorner
Hayward Baker
Queen City Farms Project Site
22715 SE 168th Way
Maple Valley, Washington 98038

Mr. Steven Tochko, P.E.
The Boeing Company
Queen City Farms Remediation Project
22715 SE 168th Way
Maple Valley, Washington 98038

Subject: Modification to Cover System PVC Geomembrane Specification
Vertical Barrier Wall System (VBWS) TRD
Queen City Farms, King County, Washington
K/J 966052.02

This letter addresses a modification to Line B of Subpart 2.01 of Specification Section 02918 of the subject TRD which states, in part, that the "Geomembrane will be of such length to allow installation from top to bottom of all slopes greater than 10 percent to avoid seaming cross slope." During installation of geomembrane within the northeast portion of the VBWS, the geomembrane installer (Layfield Plastics) extended a section of the PVC geomembrane cover to the barrier wall (along the bottom of the newly covered slope at and adjacent to Turning Point 3) using a panel that is joined along a cross-slope field seam to the larger section of upslope geomembrane. The maximum width (seam to toe of slope) of the smaller downslope geomembrane panel measured along the maximum slope is about 40 feet.

EPA has expressed concerns regarding the adequacy and uniformity of the geomembrane field seams, particularly the cross-slope field seam near Turning Point 3. Kennedy/Jenks Consultants has reviewed Layfield Plastics' field seaming procedures and testing results, and observed the field installation operation, and has found no reason to believe that the field seams are defective.

According to information provided by Layfield Plastics, the field seams at the Queen City Farms site meet the NSF Standard 54 PVC bonded field seam strength requirement of 28 lbs/in. The maximum slope inclination near Turning Point 3 is 7:1 (about 8°). The static downslope shear stress acting on the welded seam area due to the weight of the overlying final cover soils is expected to be on the order of 90 psf, or less than 1 psi. Considering a 1 inch unit length of welded seam, the anticipated shear stresses acting on the bonded PVC liner seam will be substantially below the required seam strength of 28 lbs/in and should not compromise the integrity and performance of the cover system.

Kennedy/Jenks Consultants believes that the tensile stresses induced along the field seams of the geomembrane during placement of the drainage blanket sand layer will likely produce failures along these seams if they are defective. Accordingly, a representative of Kennedy/Jenks Consultants or Hayward Baker will carefully observe the cross slope field seam near Turning Point 3 during sand placement, and note any signs of seam failure (separation). If any such signs of failure are noted, the seam will be inspected and retested, as appropriate. If a field seam is found to be defective, it will be repaired before sand placement is allowed to continue in that area. With the implementation of this precautionary inspection, we consider the geomembrane installation near Turning Point 3 to be satisfactory and consistent with the intent of the design, to minimize cross-slope field screening, presented in the 100 VBWS TRD submittal.

SPECIFICATION MODIFICATION

Modify Line B of Paragraph 2.01 of Section 02918 to read:

> "B. In addition, geomembrane will be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Geomembrane will generally be of such length to allow installation from top to bottom of all slopes greater than 10 percent to avoid seaming cross slope. Use of cross slope seaming on slopes greater than 10 percent may require special inspections or testing and must be approved by Engineer."

Please contact us at (206) 874-0555 if you have any questions or require additional information.

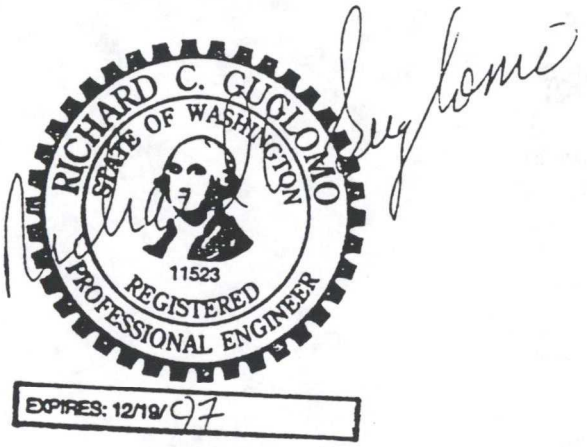
Very truly yours,

KENNEDY/JENKS CONSULTANTS

Richard C. Guglomo, P.E.
Chief Engineer

John E. Norris
Vice President

RCG/JEN:nd
9rcg1L



DESIGN ~~CLARIFICATION~~ FORM

PROJECT: Queen City Farms - Vertical Barrier Wall
OWNER: Boeing Co. CONTRACTOR: Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION
~~CLARIFICATION~~ NUMBER 5

REFERENCE OF CLARIFICATION: Specification Section 02200, Part 2 - Products, 2.05 Cobbles

CLARIFICATIONS MADE: Quarry spalls meeting WSDOT 9-13.6 were specified as a convenient alternative to the cobble materials (100% passing the 12" sieve) specified for the original cover system, because the material meeting the WSDOT specification is commercially available and meets the functional requirements of the design. The 100 percent passing the 8" sieve criteria specified in WSDOT 9-13.6 is not critical to the function of the cobble layer in the cover system and, accordingly, cobbles up to 12" in diameter as originally specified for the existing cover (i.e., passing the 12" sieve) may be present in the material used to construct the cobble layer.

APPROVED BY DESIGNER: Kennedy Jenks Consultants — Richard C. Sugimoto — 9/30/96
COMPANY NAME DATE

ACKNOWLEDGED BY OWNER: Boeing Co. — Brian A. Carlson — 10/3/96
COMPANY NAME DATE

RECEIVED BY CONTRACTOR: Hayward Baker, Inc. — FRITZ NACHTSHEIM — 10/3/96
COMPANY NAME DATE

ACKNOWLEDGED BY EPA: — Neil E Thompson — 10/3/96
NAME DATE

REMARKS:

ATTACHMENTS:

w:\96\966052.02\clarify\form5doc

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing CONTRACTOR: Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 6

LOCATION/REFERENCE OF MODIFICATION: Southern and western portions of cover system expansion (inside of the barrier wall from about Sta. 20 + 50 to Sta. 14 + 50).

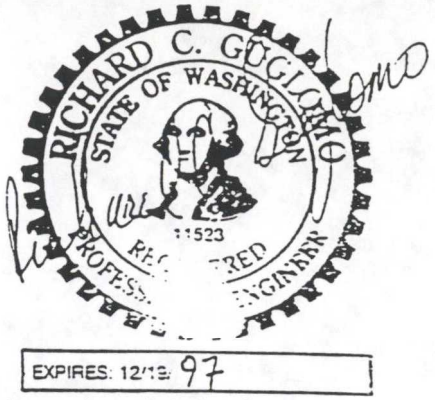
MODIFICATION MADE: Substitute geosynthetic clay liner (GCL) for silt in expanded cover system. Add new TRD Specification Section 02919 and "cover system with GCL" details. ~~Supersedes Modification No. 5.~~

	NAME	COMPANY	DATE
APPROVED BY DESIGNER:	Richard C. Sugiomo	KJC	10/3/97
ACKNOWLEDGED BY OWNER:	Brian A. Culhane	BOEING * w/ remarks	10/3/96
RECEIVED BY CONTRACTOR:	FRITZ N. ACHHORNER	HAYWARD BAKER	10/3/96
ACKNOWLEDGED BY EPA:	Neil R. Thompson	w/remarks EPA	10/3/96

REMARKS: *Add the following to 3.04(1.) If the GCL must be installed during periods of precipitation, protect the GCL roll and top of newly installed GCL from precipitation to avoid bentonite hydration. If the GCL is hydrated when no confining stress is present, remove and replace the hydrated material.
ATTACHMENTS: New TRD Specification Section 02919 and new cover details with GCL.

SECTION 02919

GEOSYNTHETIC CLAY LINER (GCL)



PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work in this section includes the requirement for manufacturing, fabrication, furnishing, and installation of the geosynthetic clay liner (GCL).

1.02 SUBMITTALS

A. Prior to construction submit the following to Boeing and Engineer for review.
   1. Manufacturer
      a. The name of the intended GCL manufacturer and the GCL type to be supplied.
      b. Test results indicating the typical minimum average values for the GCL rolls.
   2. Manufacturer's Quality Control Submittals
      a. Manufacturer's certification that GCL meets published certified properties per manufacturer's standard testing frequency as described in Section 2.01.
      b. Copies of quality control certificates for each roll of GCL identifying: a) the date of manufacture and identification number; and b) that each roll was continuously inspected for uniformity, damage, imperfections, holes, thin spots, foreign materials, tears, and punctures.
      c. Manufacturer's certification that the granular bentonite or bentonite sealing compound used for seaming, repairs, etc., is made from the same natural sodium bentonite used to produce the GCL.
   3. Shop Drawings
      a. Layout of the GCL system showing panels and seams.

B. Submit the following to Boeing and Engineer within six weeks:
   1. As-Built Drawings. Submit after demobilization from the construction site "record drawings" showing the actual installed conditions including repairs, patches, seam locations, and any other pertinent information.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications. Manufacturer will have at least 3 years continuous experience in manufacturing GCL materials.

B. Installer's Qualifications. Installer will have demonstrable experience in the successful installation of GCL.

PART 2 - PRODUCTS

2.01 GEOSYNTHETIC CLAY LINER (GCL)

A. Provide Colloid Environmental Technologies Company's (CETCO's) Bentomat ST, or approved equal. Bentomat ST is supplied in rolls of 15 foot width by 150 foot length with a weight of 2,500 pounds per roll.

B. GCL materials shall have the properties shown in following table:

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY ft^2	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tons	24 mL/ 2 g min
Bentonite Fluid Loss	ASTM D 5891	1 per 50 tons	18 mL max.
Bentonite Mass/Area[4]	ASTM D 5261	40,000 ft^2	0.75 lb/ft^2
GCL Grab Strength[3]	ASTM D 4632	200,000 ft^2	90 lbs
GCL Grab Elongation	ASTM D 4632	200,000 ft^2	15 percent typical
GCL Peel Strength	ASTM D 4632	40,000 ft^2	15 lbs
GCL Index Flux[4]	ASTM D 5887	Weekly or 500,000 ft^2	1×10^{-9} $m^3/m^2/sec$
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321	Periodic or 1,000,000 ft^2	500 psf typical

Notes:
1. Bentonite property tests performed at CETCO's bentonite processing facility before shipment to CETCO's GCL production facilities.
2. Bentonite mass/area reported at 0 percent moisture content. The reported value is equivalent to 0.95 psf at 20 percent moisture content.
3. All tensile testing is performed in the machine direction, with results as minimum average roll values unless otherwise indicated.
4. Index Flux with de-aired distilled water at 5 psi confining pressure and 2 psi head pressure. Reported value is equivalent to 925 gal/acre/day. The last 20 values may be reported from the end of the production date of the supplied GCL.
5. Peak value measured at 200 psf normal stress. Site-specific materials, GCL materials, and test conditions must be used to verify internal and interface strength of the proposed design.

B. In addition, GCL shall be produced so as to be free of blisters, undispersed raw materials, or any sign of contamination by foreign matter.

2.02 SEAM BINDING MATERIAL

A. The granular bentonite or bentonite sealing compound used for seaming, penetration sealing, and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer.

2.03 INSTALLATION EQUIPMENT

A. Core Pipe. The GCL rolls must be supported using steel pipe. The core pipe must not deflect more than three inches as measured from end to midpoint when a full GCL roll is lifted.

B. Supply a vehicle capable of lifting and suspending a roll as it is removed from a delivery truck.

C. Provide lifting chains or straps rated for at least twice the weight of the GCL roll to be used in combination with a spreader bar. The spreader bar ensures the lifting chains or straps do not chafe against the ends of the GCL roll, which must be able to rotate freely during installation. Provide a spreader bar capable of bearing the full weight of the roll being deployed without bending.

D. Provide equipment for unrolling the GCL that is capable of lifting the roll and suspending it freely such that it does not make contact with the vehicle or the ground.

E. Additional equipment needed for installation of GCL includes:
   1. Utility knives and spare blades for cutting the GCL.
   2. Granular bentonite or bentonite mastic for overlapping seams of GCLs.
   3. Waterproof tarps for temporary cover of installed material and stockpiled rolls.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. The subgrade must be compacted to at least 90 percent of the maximum density at optimum moisture content as determine by ASTM D-698. The finished subsurface must be firm and unyielding without visible pumping during or after compaction, and without abrupt elevation changes, voids, cracks, ice, or standing water.

B. The subgrade surface must be free of vegetation, sharp edged rocks, sticks, construction debris, and other foreign material that could damage the GCL. The subgrade surface material of the GCL shall have a maximum particle size of 3".

C. Roll the subgrade with a smooth-drum compactor to remove any wheel ruts, footprints, or other abrupt grade changes. Remove, crush, or push into the surface all protrusions extending more than 0.5 inches above the subgrade surface with a smooth-drum compactor.

3.02 UNLOADING

A. GCLs are typically delivered in flatbed trucks. To unload the rolls from the flatbed, insert the core pipe through the roll. This may require removal of the core plug, which shall be replaced after the roll is unloaded. Secure the lifting straps or chains to each end of the core pipe and to the spreader bar mounted on the lifting equipment. Hoist the roll straight up, while making sure its weight is evenly distributed preventing tilting or swaying when lifted.

3.03 GCL STORAGE

A. Designate a GCL storage area that is level, dry, and well-drained.

B. Store GCL rolls horizontally, in small stacks not to exceed 5 rolls in height. The bottom roll shall be placed on plywood, on an arrangement of pallets, or on some other surface to promote drainage and prevent damage to the GCL rolls.

C. While storing, cover the rolls with plastic sheeting, or other suitable material to prevent excessive hydration of bentonite in the GCL.

3.04 GCL INSTALLATION

A. Transport GCL rolls to the working area of the site in their original packaging. Immediately prior to their installations, carefully remove the packaging without damaging the GCL.

B. Equipment that could damage the GCL shall not be allowed to travel directly on it. Install GCL by unrolling it in front of backward-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

C. Install GCL such that the product name printed on one side of the GCL faces up.

D. Minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL and the subgrade surface.

E. Do not place GCL on 4:1 slopes with heights greater than 15 feet, or on 3:1 slopes with heights greater than 12 feet.

F. Place GCL so that most seams are parallel or nearly parallel to the direction of the slope.

G. Locate end-of-roll seams at least three feet from the toe and crest of slopes steeper than 4:1.

H. Lay GCL panels flat on the subgrade to eliminate wrinkles or folds.

I. Install only as much GCL as can be covered at the end of the working day with the PVC geomembrane. All geomembrane seams and repairs shall be completed during the same day. As a minimum, eliminate all potential paths for water under unsealed seams.

A QC inspector shall be present at all times during the handling, placement and covering of the GCL. Permanent cover of an area with the GCL shall be preceded by an inspection and approval by the QC inspector and a designated representative from The Boeing Company. Failure to do so will require the removal of the GCL to permit this inspection.

J. Provide a minimum GCL underlap of 24 inches beneath the existing PVC geomembrane where the new cover system ties into the existing cover system.

3.05 SEAMING

A. The contractor shall mark each panel to visually indicate the required seam overlap. Form GCL seams by overlapping their adjacent edges. Do not contaminate overlap zone with loose soil or other debris.

B. Overlap longitudinal and end-of-roll seams a minimum of 24 inches.

C. Construct seams at the ends of the panels such that the uphill GCL material overlaps the downhill GCL material to minimize the potential for runoff to enter the overlap zone.

D. Apply bentonite to each seam by exposing the underlying edge, and then applying a continuous bead or fillet of granular sodium bentonite (supplied with the GCL) along a zone defined by the edge of the underlying panel and the 24-inch overlap. Apply the granular sodium bentonite at a minimum application of one pound per lineal foot.

3.06 SEALING AROUND PENETRATIONS AND STRUCTURES

A. Cut the GCL with a sharp utility knife. Change blades frequently to avoid irregular tearing of the geotextile components of the GCL during the cutting process.

B. Seal GCL around penetrations and structures embedded in the subgrade. Apply granular bentonite liberally to seal the GCL to these structures. Use approximately 2 pounds of granular bentonite per linear foot for sealing around penetrations or structures.

C. When the GCL is placed over an earthen subgrade, excavate a "notch" into the subgrade around the penetration. Backfill the notch with granular bentonite or bentonite mastic.

D. Place a secondary collar of GCL around any penetration. First trace an outline of the penetration on the GCL and then cut a "star" pattern in the collar to enhance the collar's fit around the penetration.

3.07 DAMAGE REPAIR

A. Occasionally, a GCL roll will arrive at a job site with its protective plastic sleeve torn due to movement during transit. If this occurs, inspect the GCL for damage in the area where the sleeve was torn. If the geotextile under the torn sleeve is also torn, unwind and discard the outermost wrap of the GCL on the roll.

B. Should damage to installed GCL occur, the following procedures are to be followed:
   1. Remove equipment from the damage area and notify the Engineer.
   2. Manually clean away all soil and debris within a 2-foot radius of the damaged area using a broom in order to make the area as clean as possible.
   3. If necessary, repair the subgrade to its original condition. Replace the torn/damaged GCL as closely as possible to its original position.
   4. Place a bead of granular bentonite at a minimum rate of one-half pound per lineal foot around the damaged area.
   5. Cut a patch of new GCL to fit over and extend two feet beyond the damaged area.
   6. Place the patch over the damaged area.

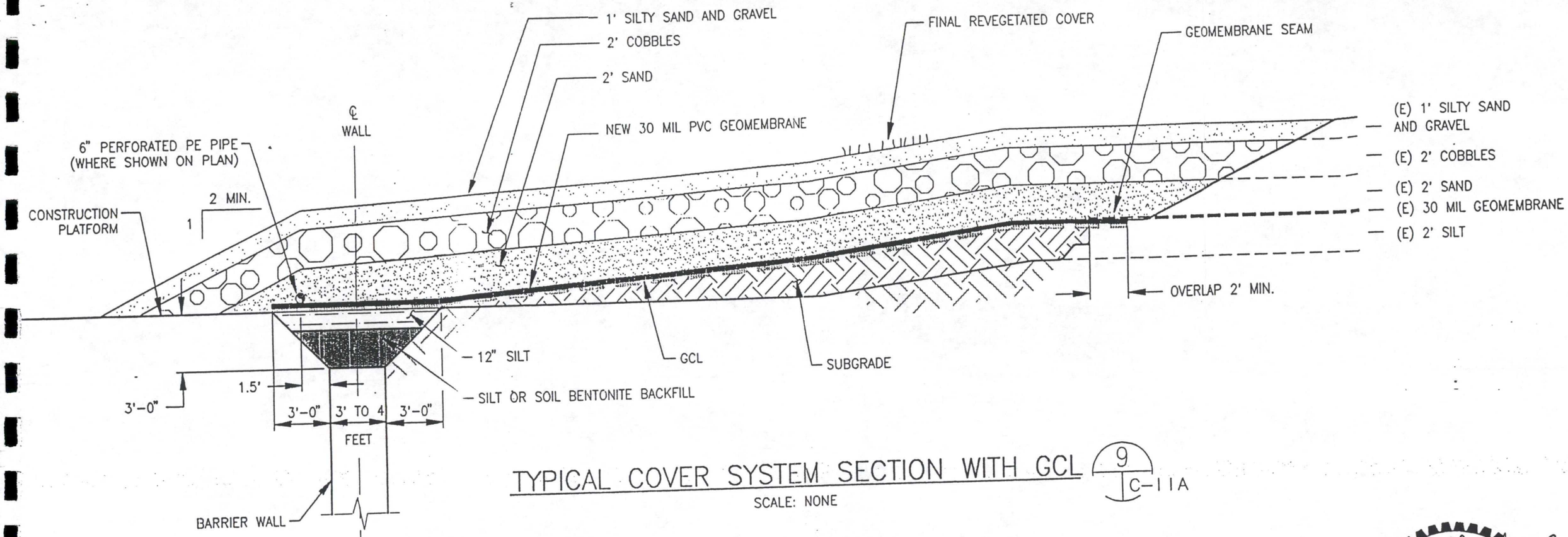
3.08 PLACEMENT OF PVC GEOMEMBRANE

A. During placement of the PVC geomembrane, utilize a temporary geosynthetic cover (a slip sheet or rub sheet) as appropriate to minimize friction during placement and to allow the PVC geomembrane to be easily moved into its final position.

3.09 CONSTRUCTION SEQUENCE

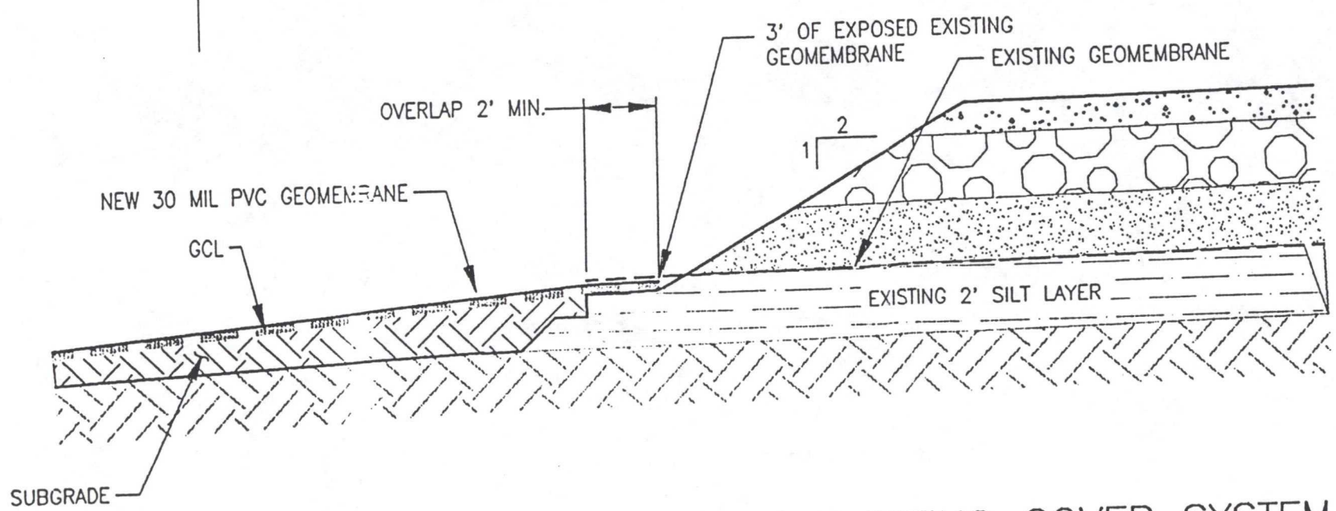
A. Perform GCL and PVC geomembrane placement using the following construction sequence:
   1. Place GCL and seal seams.
   2. Deploy and seam PVC geomembrane over GCL.
   3. Dump a load of sand at the top of all slopes where the PVC geomembrane is bonded to the existing cover system.
   4. Sequentially place sand, cobble, and soil cover layers over PVC geomembrane starting from the bottom of each slope and moving upwards to the location of the seam between the PVC geomembrane and the existing cover system.

END OF SECTION



TYPICAL COVER SYSTEM SECTION WITH GCL 9 C-11A

SCALE: NONE



TYPICAL TIE-IN OF GCL TO EXISTING COVER SYSTEM 10 C-11A

SCALE: NONE

RICHARD C. GUGLIELMO
STATE OF WASHINGTON
11523
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES: 12/19/97

Kennedy/Jenks Consultants

HAYWARD BAKER
QUEEN CITY FARMS

COVER DETAILS WITH GCL

956052/P5C015A

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing **CONTRACTOR:** Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 7

LOCATION/REFERENCE OF MODIFICATION: (1) Final Grading and Drainage Plan, Dwg C-9, and (2) Detail for Clean-Outs C-10

MODIFICATION MADE: Modify locations of clean-outs for 6-inch drain pipe; extend pipe as shown on attachment; backfill PVC clean-outs with compacted dry-mix (Sakrete)

APPROVED BY DESIGNER: Richard K. Sugiomo (NAME) Kennedy/Jenks (COMPANY) 10/24/96 (DATE)

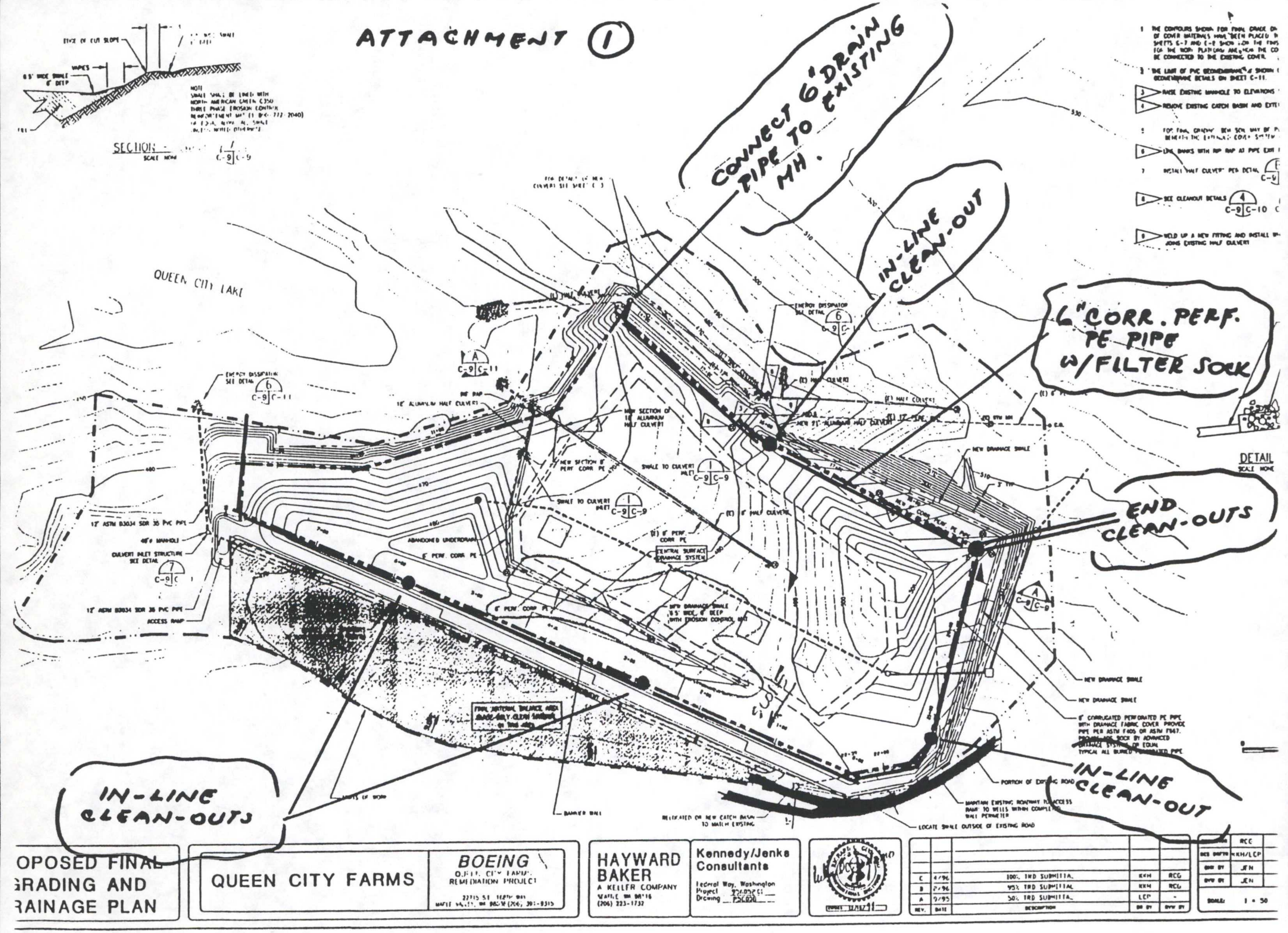
ACKNOWLEDGED BY OWNER: _____ NAME _____ COMPANY _____ DATE

RECEIVED BY CONTRACTOR: _____ NAME _____ COMPANY _____ DATE

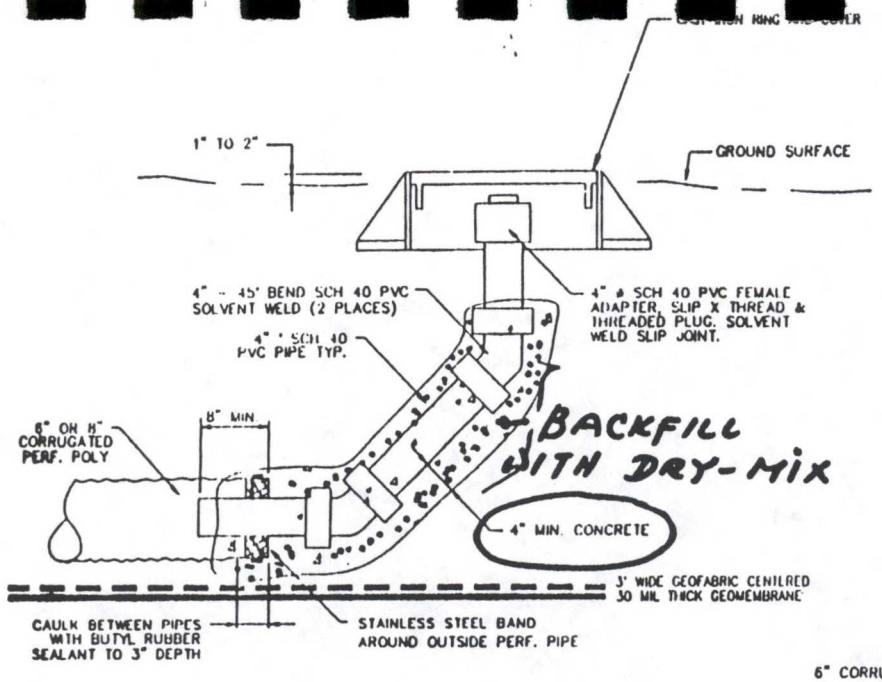
ACKNOWLEDGED BY EPA: _____ NAME _____ COMPANY _____ DATE

REMARKS:

ATTACHMENTS: No. 1 and No. 2.

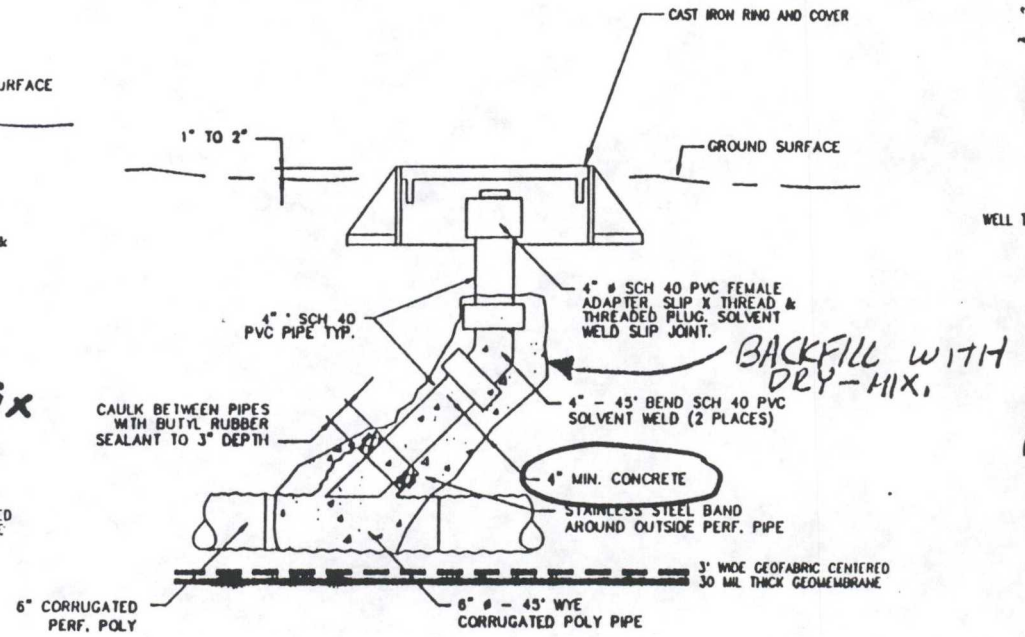


ATTACHMENT ①
CONNECT 6" DRAIN PIPE TO EXISTING MH.
IN-LINE CLEAN-OUT
6" CORR. PERF. PE PIPE W/FILTER SOCK
END CLEAN-OUTS
IN-LINE CLEAN-OUT
IN-LINE CLEAN-OUTS
QUEEN CITY LAKE
SECTION
NEW DRAINAGE SWALE
PORTION OF EXISTING ROAD
LOCATE SWALE OUTSIDE OF EXISTING ROAD
CENTRAL SURFACE DRAINAGE SYSTEM
ABANDONED UNDERDRAIN
ACCESS RAMP
DETAIL
PROPOSED FINAL GRADING AND DRAINAGE PLAN
QUEEN CITY FARMS
BOEING
QUEEN CITY FARMS REMEDIATION PROJECT
HAYWARD BAKER
A KELLER COMPANY
Kennedy/Jenks Consultants
Federal Way, Washington
100% TRD SUBMITTAL
95% TRD SUBMITTAL
50% TRD SUBMITTAL



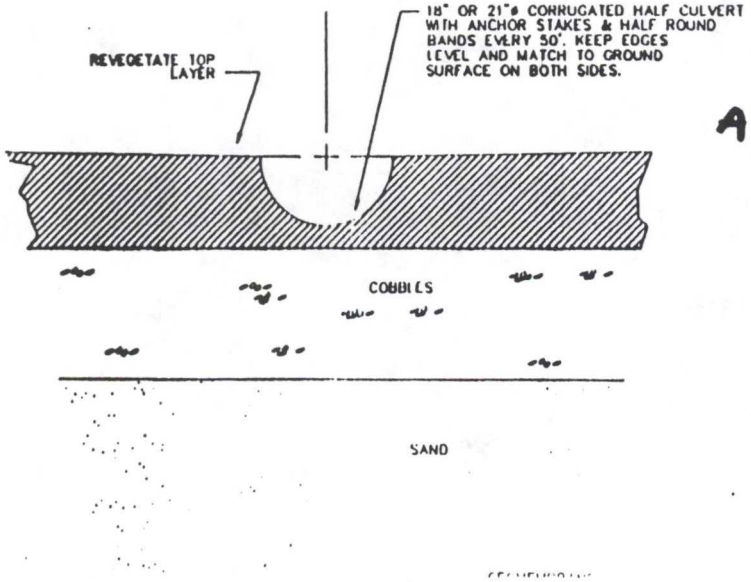
4 C-9 | C-10 CLEANOUT AT END OF CORRUGATED PERF. POLY PIPE

NOT TO SCALE

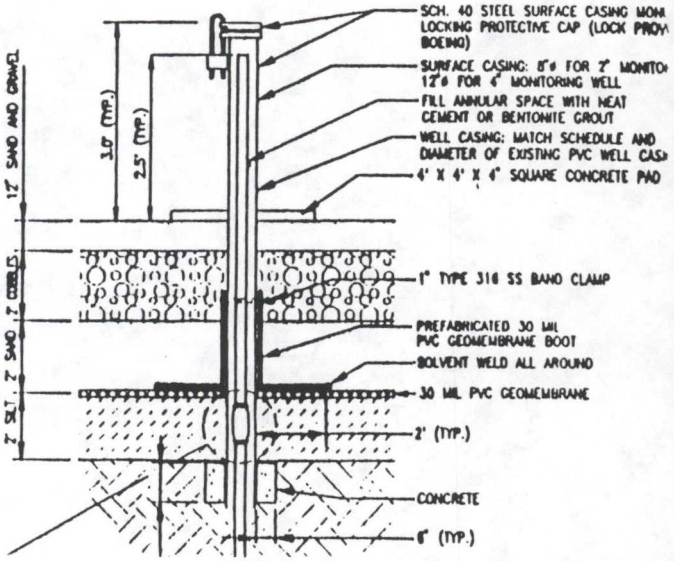


5 C-9 | C-10 CLEANOUT IN MIDDLE OF CORRUGATED PERF. POLY PIPE

NOT TO SCALE



ATTACHMENT (2)



DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing **CONTRACTOR:** Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 8

LOCATION/REFERENCE OF MODIFICATION: Embankment between Queen City Lake and the barrier wall from turning point 5 to turning point 8

MODIFICATION MADE: Grading and addition of slope protection measures

APPROVED BY DESIGNER: Richard C. Inglomo 12/4/96
NAME COMPANY DATE

ACKNOWLEDGED BY OWNER: _____
NAME COMPANY DATE

RECEIVED BY CONTRACTOR: _____
NAME COMPANY DATE

ACKNOWLEDGED BY EPA: _____
NAME COMPANY DATE

REMARKS: Construction per Attachment 1

ATTACHMENTS: No. 1 (2 sheets).

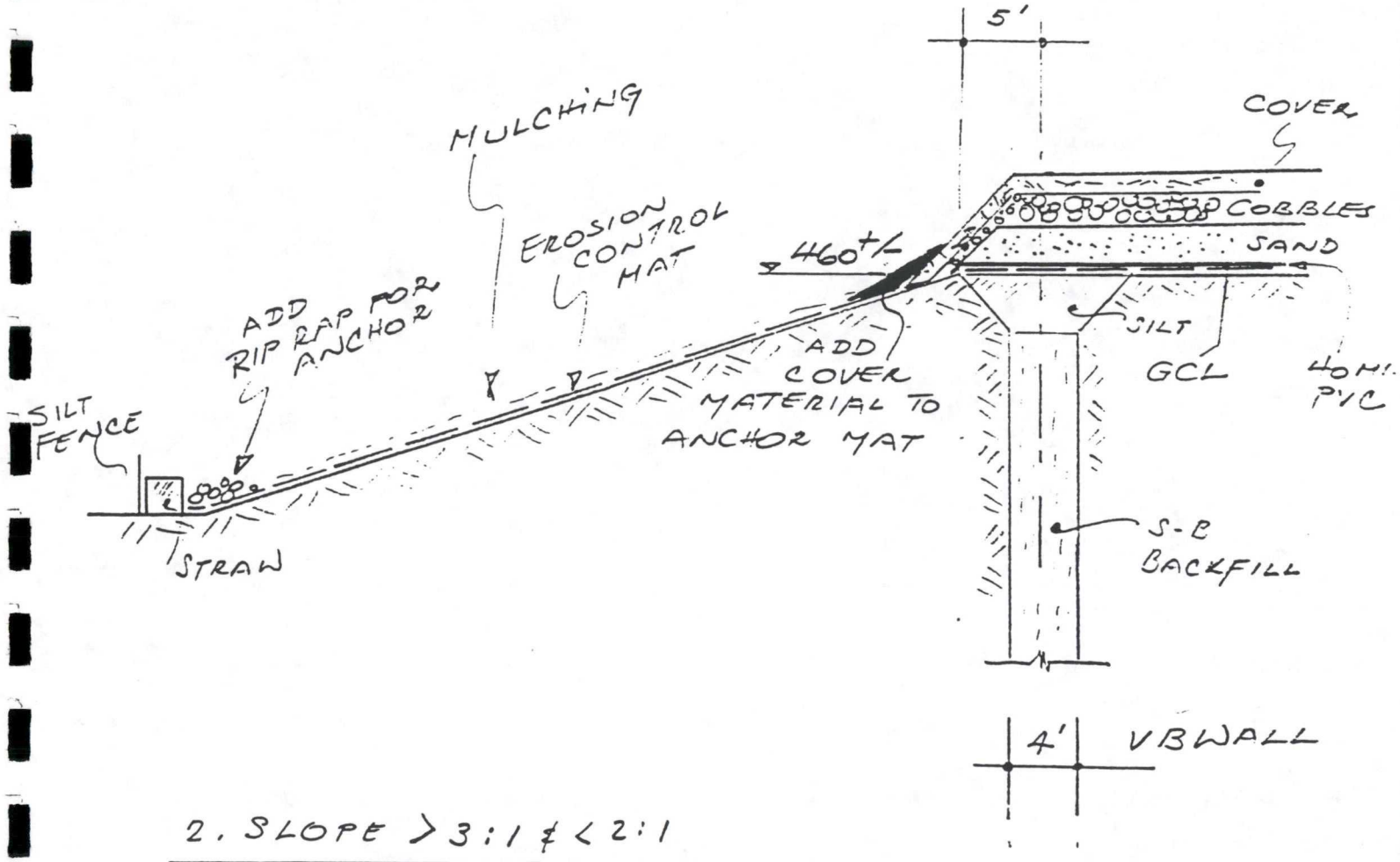
RCG 12/4/96

MODIFICATION #3 956052.01

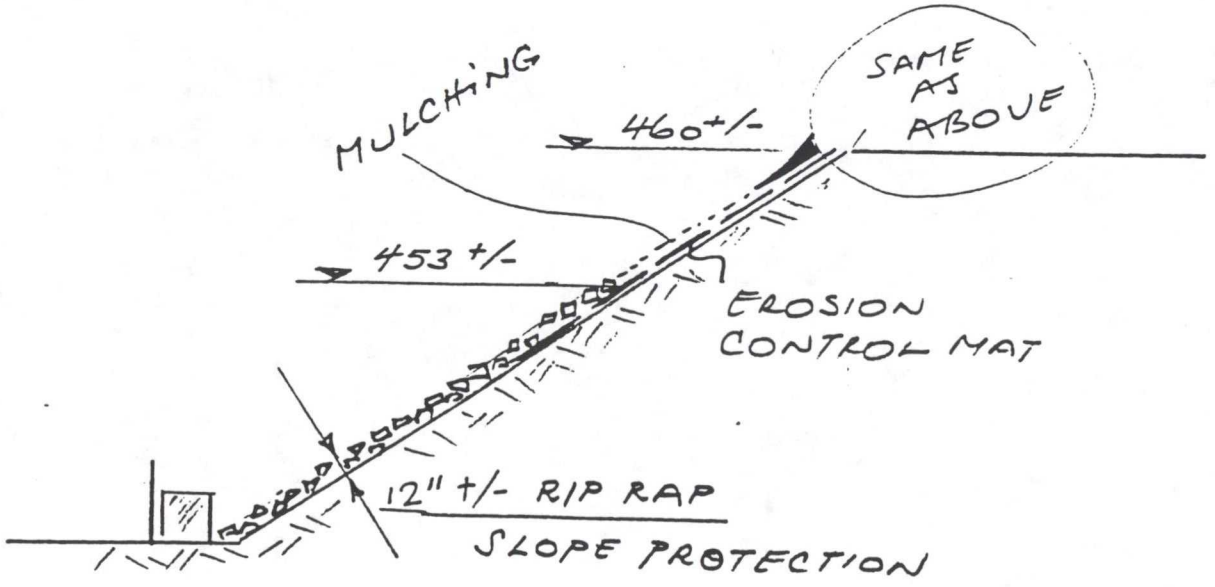
1 of 2

SLOPE ALONG QC LAKE EROSION CONTROL

1. SLOPE ≤ 3:1



2. SLOPE > 3:1 & < 2:1

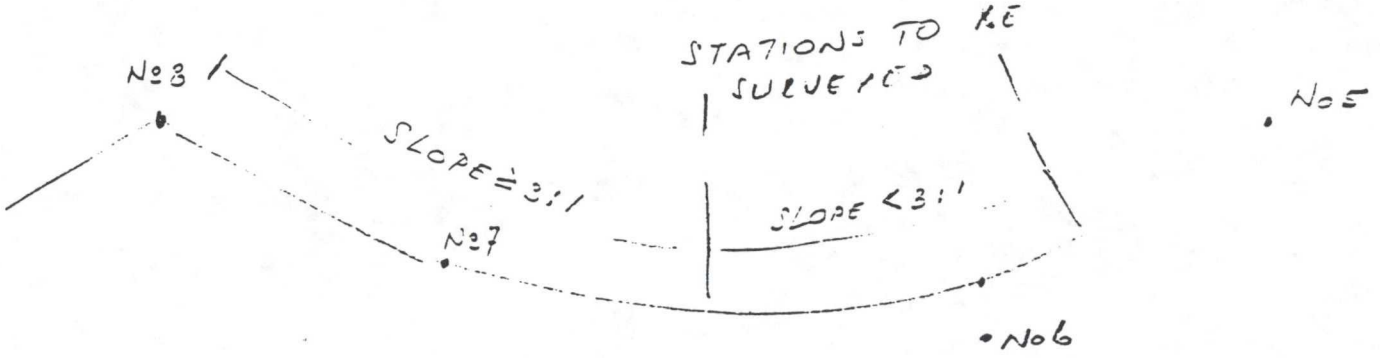


MODIFICATION #8

4 x 4 Grid Sheet **Kennedy/Jenks Consultants**

By RCG Date 12/4/96 Subject SLOPE ALONG QC LAKE EROSION CONTROL Job No. 956052.01

Checked By _____ Date _____ Sheet 2 of 2



DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing **CONTRACTOR:** Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 9

LOCATION/REFERENCE OF MODIFICATION: Throughout cover system expansion.

MODIFICATION MADE: Change TRD Specification Section 02200 by adding Paragraph 2.06 B. Refer to attached letter dated 4 December 1996.

APPROVED BY DESIGNER: Richard C. Sugimoto KJS 12/4/96
NAME COMPANY DATE

ACKNOWLEDGED BY OWNER: _____
NAME COMPANY DATE

RECEIVED BY CONTRACTOR: _____
NAME COMPANY DATE

ACKNOWLEDGED BY EPA: _____
NAME COMPANY DATE

REMARKS: _____

ATTACHMENTS: Kennedy/Jenks Consultants' letter to Hayward Baker and Boeing dated 4 December 1996.

Kennedy/Jenks Consultants

Engineers and Scientists

530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

4 December 1996

Mr. Alan Ringen
Hayward Baker
Queen City Farms Project Site
22715 SE 168th Way
Maple Valley, Washington 98038

Mr. Steven Tochko, P.E.
The Boeing Company
Queen City Farms Remediation Project
22715 SE 168th Way
Maple Valley, Washington 98033

Subject: Modification to Silty Sand and Gravel Specification
Vertical Barrier Wall System (VBWS) TRD
Queen City Farms, King County, Washington
K/J 956052.02

Dear Messrs. Ringen and Tochko:

This letter addresses modifications to Part 2 of Specification Section 02200 of the subject TRD. The results of Hong West & Associates' gradation testing of material currently placed as the top layer of the VBWS cover system indicate that some of this material does not meet the silty sand and gravel specification established in Specification Section 02200, Paragraph 2.06 A. Kennedy/Jenks Consultants has determined that the well graded material represented by the samples provided to Hong West & Associates will provide an adequate final layer for the site cover system. Accordingly, the silty sand and gravel specification will be modified by adding a new paragraph.

SPECIFICATION MODIFICATION

Modify Paragraph 2.06 of Section 02200 by adding the following:

"B. The silty sand and gravel layer of the cover system shall consist of well graded soils meeting the following gradation:

Sieve Size	Percentage Passing (by weight)
6"	100
3"	90-100
U.S. No. 200	12 maximum"

This modified specification is consistent with the intent of the extended cover system design presented in the 100 percent VBWS TRD submittal. Please contact us at (206) 874-0555 if you have any questions or require additional information.

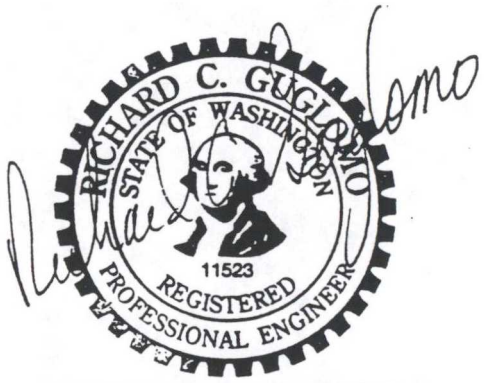
Very truly yours,

KENNEDY/JENKS CONSULTANTS

Richard C. Guglomo, P.E.
Chief Engineer

John E. Norris
Vice President

RCG/JEN:ll
12rcg1L.doc



EXPIRES: 12/19/97

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing **CONTRACTOR:** Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 10

LOCATION/REFERENCE OF MODIFICATION: Cover system underdrain cleanouts.

MODIFICATION MADE: Modify cleanout details shown on Sheet C-10 to conform to those shown on Attachment 1.

APPROVED BY DESIGNER: Richard C. Sugiomo KJC 12/12/96
NAME COMPANY DATE

ACKNOWLEDGED BY OWNER: _____
NAME COMPANY DATE

RECEIVED BY CONTRACTOR: _____
NAME COMPANY DATE

ACKNOWLEDGED BY EPA: _____
NAME COMPANY DATE

REMARKS: _____

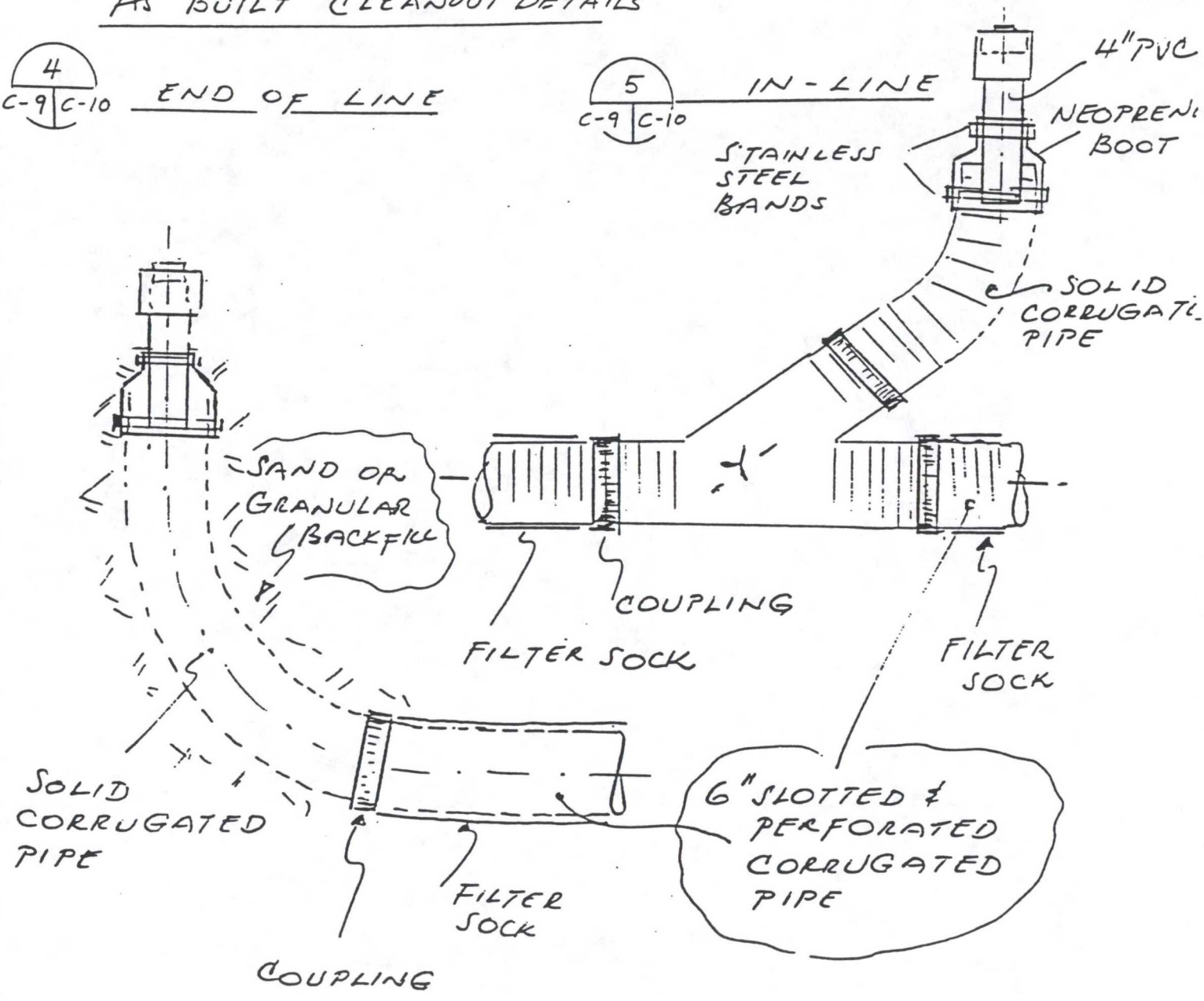
ATTACHMENTS: Attachment No. 1 - As-Built Cleanout Details.

ATTACHMENT 1
(MODIFICATION No. 10)

AS BUILT CLEANOUT DETAILS

4 C-9 | C-10 END OF LINE

5 C-9 | C-10 IN-LINE



NOTE: PROVIDE CAST IRON RINGS AND COVERS AS SHOWN ON SHEET C-10.

DESIGN/SPECIFICATION MODIFICATION FORM

PROJECT: Queen City Farms - Vertical Barrier
OWNER: Boeing CONTRACTOR: Hayward Baker, Inc.
LOCATION: Maple Valley, WA

MODIFICATION NUMBER 11

LOCATION/REFERENCE OF MODIFICATION: Throughout project site areas disturbed by construction activities that are to be seeded.

MODIFICATION MADE Change to TRD Specification Section 02270 by adding Paragraph 2.04. Refer to attached letter dated 11 September 1997.

APPROVED BY DESIGNER: Richard Seglowa KJS 9/11/97
NAME COMPANY DATE

ACKNOWLEDGED BY OWNER: _____
NAME COMPANY DATE

RECEIVED BY CONTRACTOR: _____
NAME COMPANY DATE

ACKNOWLEDGED BY EPA: _____
NAME COMPANY DATE

REMARKS: _____

ATTACHMENTS: 1. Kennedy/Jenks Consultants' letter to Boeing dated 11 September 1997
2. Terra Dynamics, Inc. letter to Hayward Baker dated 12 August 1997

Kennedy/Jenks Consultants

Engineers and Scientists

530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

11 September 1997

Mr. Brian Anderson
Boeing Commercial Airplane Group
Queen City Farms Remediation Project
22715 SE 168th Way
Maple Valley, WA

Subject: Terra Dynamics Proposed Alternative Hydroseed Mix
Queen City Farms Vertical Barrier Wall System
K/J 956052.01

Dear Mr. Anderson:

This letter addresses modifications to Part 2 of Specification Section 02270 of the subject TRD. We have reviewed the alternative hydroseeding mix design proposed by Terra Dynamics, Inc. for use at the Queen City Farms project site (see attached letter from Terra Dynamics, Inc. to Hayward Baker dated 12 August 1997). We feel that this mixture is the functional equivalent mix design specified in section 02270 of the Task Remedial Design Report (Kennedy/Jenks Consultants, 1996). It is our understanding that both you and Dwayne Peterson of Hayward Baker have given verbal approvals of the alternate as well.

Accordingly, the seeding and fertilizing specification will be modified by adding a new paragraph.

SPECIFICATION MODIFICATION

Add Paragraph 2.04 to Section 02270 as follows:

2.04 HYDROSEED

A. Hydroseed mixture will be the following:

Seed	80 lb/acre	10% Bentgrass 40% Perennial Rye 40% Creeping Red Fescue 10% White Clover
	10 lb/acre	Pacific Northwest Wildflower Mix
Fertilizer	520 lb/acre	26-12-12 w/Timed Release Nitrogen
Tackifier	40 lb/acre	Guar Based Tackifier

B. Mulch. Use natural wood cellulose fiber mulch containing no germination or growth inhibitors. Apply at 2,000 pounds per acre.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Richard C. Guglomo, P.E.
Chief Engineer

John E. Norris
Vice President

RCG/JEN:nd
9rcg1l.doc

Attachment

cc: Alan Ringen, Hayward Baker
Tina Scoccolo, Terra Dynamics

RICHARD C. GUGLOMO
STATE OF WASHINGTON
1525
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES: 12/19/97

To: Chris Kovac
From: Alan Ringen
253-952-3435

TERRA DYNAMICS INC.
Experts in Landscaping & Reliability.

August 12, 1997

Hayward Baker - Western Region
~~224 W. Santa Maria~~ 1780 Lemonwood Dr.
Santa Paula, CA 93060

ATTN: Mr. Alan Ringen
Project Manager

RE: Queen City Farms Remediation
Maple Valley, WA

Dear Mr. Ringen:

We have been asked to provide pricing and other information for hydroseeding the above referenced jobsite. After a site review and meeting with representatives from Hayward Baker - Duane Peterson, Boeing - Brian Anderson, and Kennedy/Jenks - Christopher Kovac, last Thursday, we are providing the following for your review and approval.

The proposed hydroseeding mix design has been modified from the originally specified mix in Section 2270 of the specifications. It is the standard erosion control mix for the Washington State Department of Transportation. We suggested this modification after reviewing the soil conditions and needs of the owner. Everyone at the site meeting reviewed the proposed mix and verbally agreed to its use.

It is assumed that we will hydroseed on or around the week of September 8, 1997. Water source will be at the Stoneway pit standpipe. Duane Peterson to obtain permission from Stoneway. We will hydroseed the entire site in one mobilization.

SEED	80# / ACRE	10% Bentgrass 40% Perennial Rye 40% Creeping Red Fescue 10% White Clover
	10# / ACRE	Pacific Northwest Wildflower Mix
FERTILIZER	520# / ACRE	26-12-12 w/ Timed Release Nitrogen
MULCH	2,000# / ACRE	Wood Cellulose Fiber Mulch
TACKIFIER	40# / ACRE	Guar Based Tackifier

The area is estimated to be 12.75 acres.

PRICE: $980.00 PER ACRE @ 12.75 acres = $12,495.00

P.O. Box 69667 Seattle WA 98188 (206) 575-1303 Fax (206) 575 8508 TERRA01133LT

28 June 1996

MEMORANDUM

To: Project File

From: Kurt W. Hoppen KWH

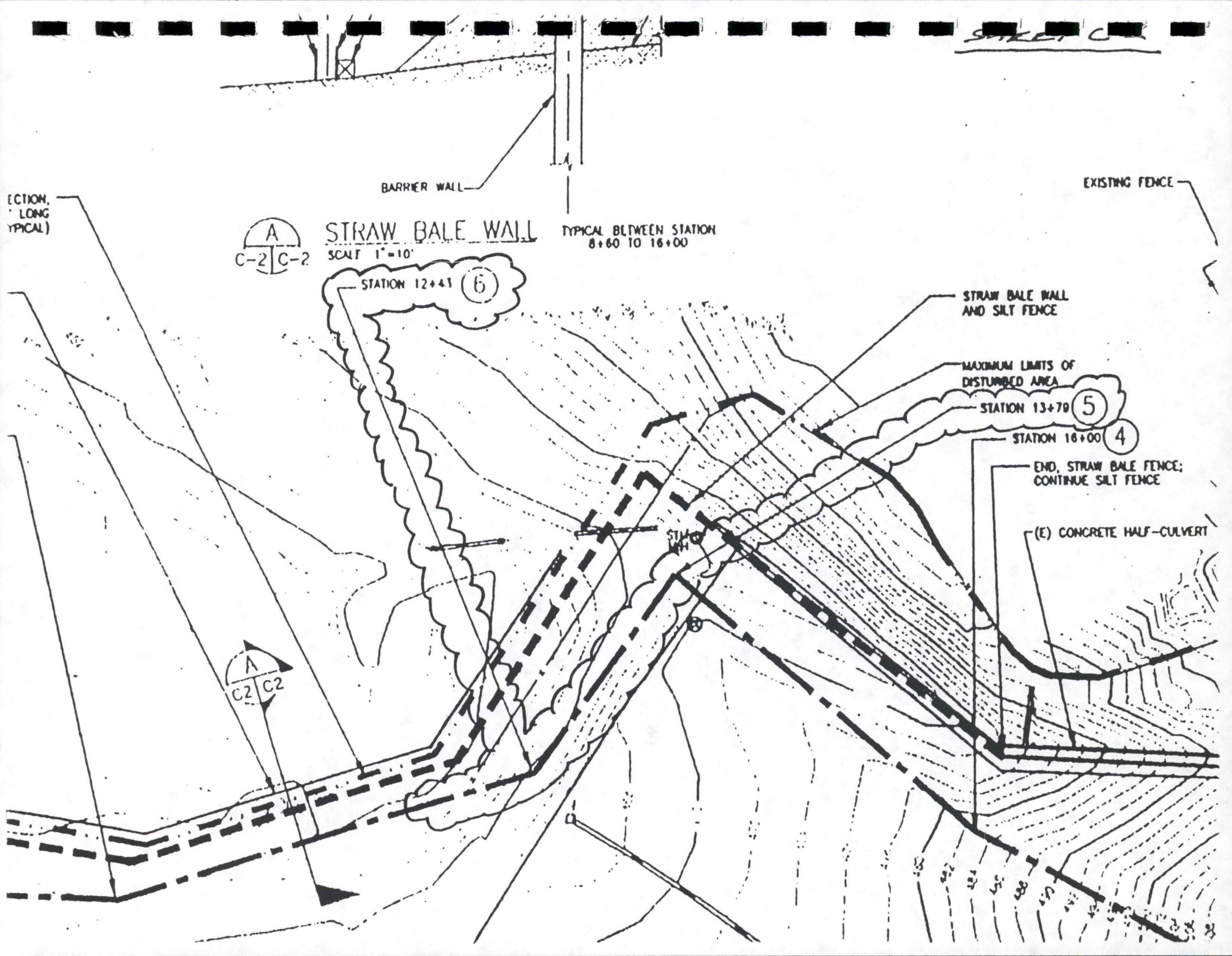
Subject: Barrier Wall Curve Stationing
Queen City Farms Barrier Wall System Task Remedial Design
The Boeing Company
King County, Washington
K/J 956052.01

The following information regarding the barrier wall alignment was reviewed during separate discussions with Chris Kovac - Hayward Baker; and Scott Mathees, and Frank Mocker - Golder & Associates. The discussions took place during a 27 June 1996 site visit.

1. The barrier wall trench between Turning Point 5, Sta. 13+79, and Sta. 11+70, approximately, is being constructed along a curve instead of on the straight design centerline alignment indicated on sheet C-2. The curve enables the trench to be constructed continuously without having to stop to construct Turning Point 6, Sta. 12+43, using the typical turning point construction method. The curve is expected to reduce the time required to construct the barrier wall trench in the vicinity of Turning Point 6.
2. The curve alignment is located outside of the designed centerline alignment indicated on plan sheet C-2. Therefore the cap zone will not be reduced as a result of the trench realignment.
3. Station offset lines were surveyed by David Evans & Associates north of the centerline on either side of Sta. 12+43. Chris Kovac subdivided the offset lines into 10-foot intervals to establish the locations at which Frank Mocker would take depth soundings in the trench.
4. It was discovered while subdividing the offset lines that the curve length was approximately 20-feet shorter than the design centerline length. Kennedy/Jenks Consultants advised Chris to use station correction equations at the beginning and end of the curve, Sta. 13+79 and Sta. 11+70, approximately. The equations would account for the actual length along the curve without changing the stationing of the trench sections constructed along the design centerline.
5. While Frank and Scott were sounding the barrier wall trench and verifying the station of each sounding location, they determined that the curve alignment varies only slightly from the design alignment between Sta. 13+79 and Sta. 12+50, approximately. Therefore, the 20-foot trench length difference occurs between Sta. 11+70 and Sta. 12+50, approximately.

6. The station correction equations will apply to the alignment between Sta. 11+70 and Sta. 12+50, approximately.
7. Frank and Scott pointed out that the most critical aspect of the trench within the curve section is the step that occurs at design Sta. 12+17. At that point, the trench depth changes from elevation 417 to elevation 408. The curve stations assigned to the step are Sta. 12+17 (Design) and Sta. 12+37 (As-Built). The actual station will be determined by the as-built survey that will be made at a later date.
8. Chris, Scott, and Frank will determine and agree on the station number of the point at which the trench construction resumes along the design alignment indicated on the drawings.

cc: Chris Kovac - Hayward Baker
Scott Mathees - Golder & Associates


BARRIER WALL
EXISTING FENCE
ECTION,
LONG
YPICAL)
A
C-2 C-2
STRAW BALE WALL
SCALE 1"=10'
TYPICAL BETWEEN STATION
8+60 TO 16+00
STATION 12+43 6
STRAW BALE WALL
AND SILT FENCE
MAXIMUM LIMITS OF
DISTURBED AREA
STATION 13+70 5
STATION 16+00 4
END, STRAW BALE FENCE;
CONTINUE SILT FENCE
(E) CONCRETE HALF-CULVERT
A
C2 C2

HAYWARD BAKER
A Keller Company

Boeing Jobsite # 53099

Queen City Farms
22715 SE 168th Way
Maple Valley, WA 98038
206-391-8807 Telephone
206-391-9588 FAX
206-391-2825 Fritz's Phone

TELEFAX

To: Kurt Hoppen Date: 6 / 27 / 1996

Company: Kennedy / Jenks Total Pages: 1+ 1 = 2

Fax #: (206) 952-3435

From: Chris Kovac

Message: attached comments

Thanks,

Chris

KELLER

Tampa, Florida	813-884-3441
Chicago, Illinois	708-368-1717
Des Moines, Iowa	515-276-5464
Odenton, Maryland	410-551-8200
Fort Worth, Texas	817-625-4241
Seattle, Washington	206-223-1732
Maple Valley, Washington	206-391-9588
Santa Paula, California	805-933-1336

6/27/96

Kurt,

The memo looks good to me. It is my feeling that the word "approximately" remain where you have used it. I feel that it is important because the centerline and the curved-cut stations are approximately the same from 13+79 to approximately 12+50 (where the radius of curvature is large). The stations begin to diverge at Station 12+50 where the radius of curvature decreases. It is in this latter area where the change in length probably occurs

Thanks for all your help.

Chris

Kennedy/Jenks Consultants

Engineers and Scientists
530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

A TELEFAX FOR:

Name: Chris Kovac *Date:* 27-Jun-96 *Time:* 4:12 PM

Company: Hayward Baker *From:* Kurt W. Hoppen

Telefax Number: 391 - 9588 *K/J No.:* 956052.01

Subject: Barrier Wall Curve Stationing - *DRAFT*
Queen City Farms

Special Instructions:

Comments required by _____ *Comment to* _____

For your approval:

Approval required by _____ *Comment to* _____

☐ *For your review* ☐ *For your information* ☐ *As noted*

Comments:

I will appreciate your reviewing and comments on the following. I will fax it to Scott and Frank for their review after I receive your input. This issue is critical enough that I want to make sure all of the information is straight.

THANKS!!!

A total of ____ pages, including this cover page, have been sent. If you have not received the indicated number of pages, please call (206) 874-0555 as soon as possible

Kennedy/Jenks Consultants

Engineers and Scientists
530 South 336th Street
Federal Way, Washington 98003
206-874-0555 (Seattle)
206-927-8688 (Tacoma)
FAX 206-952-3435

A TELEFAX FOR:

Name: Scott Mathees *Date:* 28-Jun-96 *Time:* 9:55 AM

Company: Golder & Associates *From:* Kurt W. Hoppen

Telefax Number: 391 - 7605 (Boeing) *K/J No.:* 956052.01

Subject: Barrier Wall Curve Stationing - *DRAFT*
Queen City Farms

Special Instructions:

Comments required by _____ *Comment to* _____

For your approval:

Approval required by _____ *Comment to* _____

☐ *For your review* ☐ *For your information* ☐ *As noted*

Comments:

FAXED
DATE 6/29/96
BY _____

I will appreciate your review and comments on the following.

THANKS!!!

A total of 7 pages, including this cover page, have been sent. If you have not received the indicated number of pages, please call (206) 874-0555 as soon as possible

SHOP DRAWING REVIEW LETTER

KENNEDY/JENKS CONSULTANTS
530 South 336th Street
Federal Way, WA 98003
(206) 874-0555

To: Hayward Baker.
Queen City Farms
22715 S.E. 168th Way
Maple Valley, WA 98038

Attention: Chris Kovac

Page No.: 1
Date: 9 July 1996
Serial No.:
Spec. Ref.:
Project: Queen City Farms
Barrier Wall System
K/J JOB NO.: 956052.01
Submittal: 1

A. The action noted below has been taken on the enclosed Drawings:

NET = No Exceptions Taken
MCN = Make Corrections Noted
A&R = Amend and Resubmit
RR = Rejected, Resubmit
NR = Not Reviewed

Item	K/J Action	Refer to Comment	Manufacturer or Supplier	Title of Submittal
1-1	NET	1	Hayward Baker	Monitoring Well Extension Coupling

Comments:

1. The attached is an acceptable alternative to the Monitoring Well Extension Detail depicted on sheet C-10. The two couplings indicated on the alternative detail perform the same function as the boot indicated on C-10, and provide a more convenient method for assembling the extension.

B. Corrections or comments made on the Shop Drawings during this review do not relieve the Contractor from compliance with the requirements of the Drawings and Specifications. This check is only for review of general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication process and techniques of construction, coordinating their work with all other trades, and performing their work in a safe and satisfactory manner.

Distribution	SDRL	Encl.
Hayward Baker	2	
Boeing	1	
Kennedy/Jenks Consultants	1	

By
Kurt W. Hoppen, P.E.
Project Engineer

HAYWARD BAKER
A Keller Company

Boeing Jobsite # 53099

Queen City Farms
22715 SE 168th Way
Maple Valley, WA 98038
206-391-8607 Telephone
206-391-9588 FAX
206-391-2625 Fritz's Phone

TELEFAX:

To: Dick Guglomo Date: 7 / 8 / 1996

Company: Kennedy/Jenks Total Pages: 1+ 1 : 2

Fax #(206) 952 - 3435

From: Chris Kovacs

Message: Dick,

Here's a sketch of the proposed Monitoring Well extension coupling.

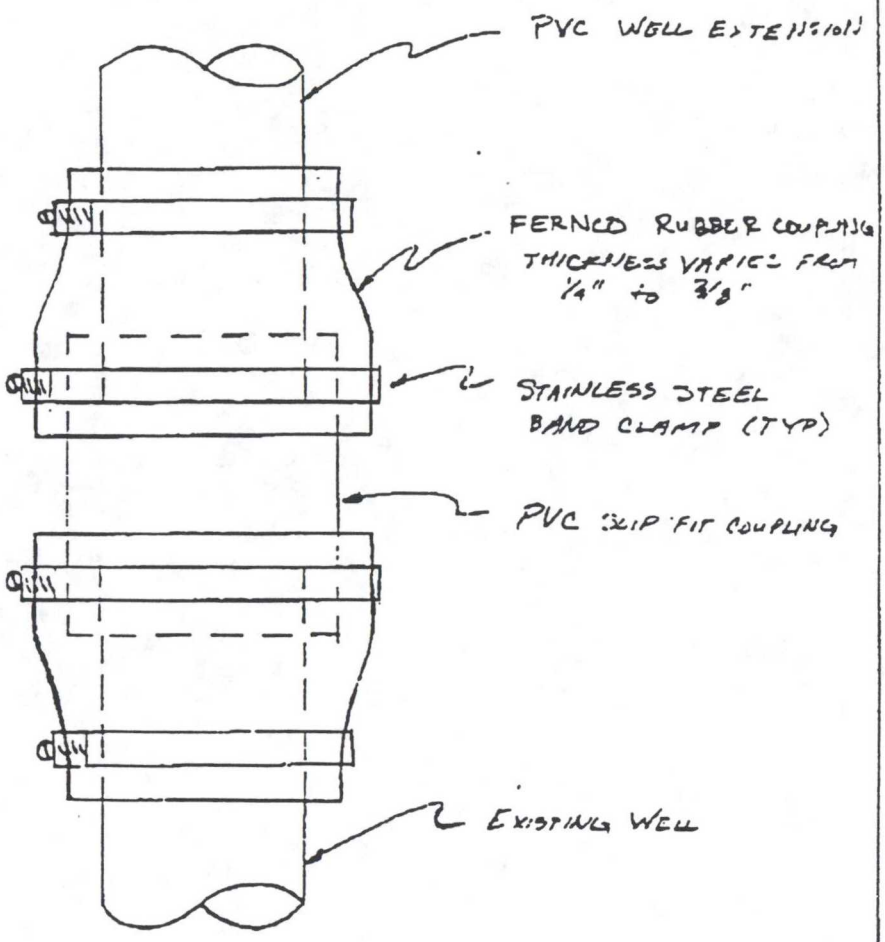
Thanks

Chris

KELLER

Tampa, Florida 813-684-3441
Chicago, Illinois 708-355-1717
Des Moines, Iowa 515-276-5464
Odenton, Maryland 410-551-8200
Fort Worth, Texas 817-625-4241
Seattle, Washington 206-223-1732
Maple Valley, Washington 206-391-9588
Santa Paula, California 805-933-1358

SHOP DRAWING REVIEW S.D. No. 1-1		
ACTION Subject to all provisions of Project Plans and Specifications		
✓ NO EXCEPTIONS TAKEN		AMEND & RESUBMIT
MAKE CORRECTIONS NOTED NO RESUBMISSION REQUIRED		REJECTED RESUBMIT
Kennedy/Jenks Consultants By [signature] Date 10 JUL 96		



NO GLUES OR SOLVENTS

PROPOSED DETAIL OF MONITORING WELL EXTENSION COUPLING

DRAWN BY : CHRIS KOVAC @ HAYWARD BAKER
DATE : 7/8/96
SCALE : NONE

LETTER OF TRANSMITTAL

KENNEDY/JENKS CONSULTANTS

530 South 336th Street
Federal Way, WA 98003
(206) 927-8688

TO: Hayward Baker
22715 SE 168th Way
Maple Valley, WA 98038

DATE: 24 June 1996
ATTENTION: Chris Kovac
SUBJECT: Queen City Farms
Barrier Wall System
Maple Valley, Washington
K/J JOB NO.: 956052.01

We are sending you: (X) Attached ( ) Under Separate Cover

via: ( ) Mail ( ) Overnight ( ) Courier (X) Hand Delivery

the following items:

( ) Plans ( ) Prints ( ) Specifications ( ) Samples
( ) Shop Drawings ( ) Copy of Letter ( ) Change Order (X) Other

Copies	Date	No.	Description
2	10 Jul 96		Shop Drawing Review Letter

(X) For information and coordination ( ) Return material when review completed

( ) As requested ( ) Return after loan to us

Remarks:

KENNEDY/JENKS CONSULTANTS

By: _____
Kurt W. Hoppen, P.E.
Project Engineer